SCHOOL SCIENCE AND MATHEMATICS

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FRONTIERS IN SCIENCE AND MATHEMATICS TEACHING

ALLEN F. MEYER, *Vice-President*
Central Association of Science and Mathematics Teachers

Who are your friends?

You will see many of them at the fiftieth annual convention of the Central Association of Science and Mathematics Teachers.

Are sociometric studies and other polls being made of your status and of the status of your child?

You will learn of these and of many others at the convention.

Do you find yourself suddenly in the entertainment business at home or at work?

You will find a chance to match your technique with that of others at the convention.

Are you rediscovering how strong or how frail civilization is?

You will acquire new inspiration at the 1950 convention.

Have you noted that one acquaintance or another, assigned to a responsible position, was chosen as much for his personality as for his technical accomplishments?

You will have a chance to participate in appreciating anew the ever changing importance of human values, technical training, and time relationships, at the convention.

Have you discovered how to help prepare your successor?

Are young men coming along and becoming more expert than you are, in some particular, that is?

Be not bitter. Be with them at the Golden Anniversary Convention of our Association.

Do your pupils understand all that they know?

You can help us with this, our problem too, at the Edgewater Beach Hotel on November 24 and 25.

OUR ANNIVERSARY BOOK ADVERTISED ALL OVER THE WORLD

On March 30 a special committee of four stuffed 4,000 envelopes with a copy each of the anniversary book folders, and made preparations for their mailing. The Business Department of Washington High School here at Indianapolis contributed student help to address the "mountain" of envelopes. We express our sincere thanks for this help.

One is amazed at the large number of subscribers to the Journal in foreign countries. Included in these are not only large countries like France, India, China, England, Soviet Russia, Brazil and Argentina but also some of the tiniest island countries. We were especially surprised at the rather large list of subscribers in Czechoslovakia. To all these subscribers in foreign countries went the same announcement of the prepublication price of $2.50 that went to you. This is our last reminder of this offer. After September 1 the regular price of $3.00 will prevail. Now is the time to secure your copy of the anniversary book by sending an order to Mr. Ray C. Soliday, Box 408, Oak Park, Illinois.

J. E. Potzger,
Chairman, Promotion Committee
Butler University, Indianapolis, Indiana

WILEY TO DISTRIBUTE CARUS MONOGRAPHS

John Wiley & Sons has been appointed by the Mathematical Association of America to handle the distribution of the Association's well-known series, the Carus Mathematical Monographs.

Later in the spring, Wiley will make available monographs 9 and 10 in the series, earlier monographs having been distributed by the Open Court Publishing Company of La Salle, Illinois. Monograph 9 is entitled "The Theory of Algebraic Numbers" and was written by Professor Harry Pollard of Cornell University. Monograph 10, by Professor B. W. Jones of the University of Colorado, is on the subject of "The Arithmetic Theory of Quadratic Forms." Each publication is priced at $3.00.

The Carus Mathematical Monographs are a series of expository presentations intended to make topics in pure and applied mathematics accessible to mathematicians as well as to non-specialists and scientific workers in other fields. Their publication has been made possible by a gift to the Mathematical Association of America from the late Mrs. Mary Hegeler Carus.

WHY NOT DEMONSTRATE IT?

ROBERT H. LONG
Green Mountain Junior College, Poultney, Vermont

A striking demonstration of a property, as teachers know, is an excellent way to help students fix a fact or a principle in their minds. In chemistry as well as other subjects so often the content is passed along to the students by the study and discussion of printed pages of books. Visual presentation is often in the form of a neat diagram in the book or on the blackboard. It is so easy to tabulate facts or make diagrams that often the instructor is a victim of the twin "road blocks" to better teaching— "it is too simple to demonstrate or, there is no easy way to present the idea in working form." While it must be granted that some principles and properties cannot be demonstrated with materials and apparatus usually available in a general chemistry laboratory, it is good to abide by the rule that *if it is worth teaching, it is worth demonstrating*. Mixing a little ingenuity with a will to actually demonstrate the properties and principles will aid in overcoming the often-offered objection that some teachers do not have the ability to devise original demonstrations. A file of interesting demonstrations published in professional magazines will go a long way in enabling the teacher to demonstrate more of the subject matter of a course. One who makes a sincere effort to follow the rule of demonstrating concepts whenever possible will be rewarded by greater student interest as well as a higher level of achievement. Observing teachers, without doubt, have always been aware of the fact that a class of students will show much more interest in a going demonstration than in a diagram. With all the improvements in methods of science teaching, there is yet far too much learning without action.

The writer has developed the following demonstrations to present principles and properties not usually demonstrated. They have been found to be useful and of interest to students; and are passed along to other teachers for what they are worth. They are, for the most part, extremely simple and require simple apparatus; but after all one of the factors of good teaching is getting the, what seems to the teacher, little ideas across to the students—they are not always such simple ideas to the students.

THE DENSITY OF AMMONIA

The fact that ammonia gas is lighter than air can be interestingly demonstrated as shown in Figure 1. The beaker is inverted on a ring of suitable size. The glass cylinder is filled with the gas from a genera-

tor, and, while inverted, brought near the mouth of the beaker. Then as the ammonia is poured upward into the container, the phenolphthalein-dampened paper gradually changes color.

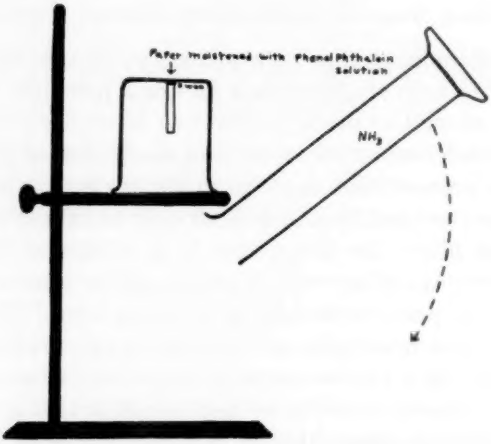


FIG. 1 Pouring ammonia gas upward.

MOVEMENT OF IONS IN ELECTROLYSIS

Of all the principles encountered in elementary chemistry, one of the difficult to demonstrate is that of ion movement in electrolysis. Since this is one of the important evidences for the theory of ions, it is worth demonstrating. First-hand study of the evidences will generally lead to more interest in a theory. The movement of permanganate ions to the anode during electrolysis can be clearly demonstrated as shown in Figure 2. The permanganate ion is used

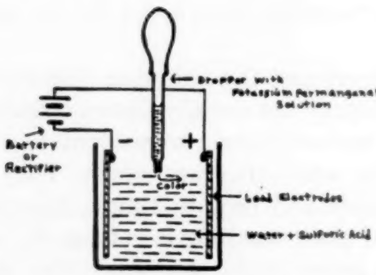


FIG. 2. Demonstrating the movement of ions.

here because of its color. (This demonstration can best be presented to small groups so that the students can look down on the apparatus.) The current and sulfuric acid-water solution should be of such strength that vigorous electrolysis will go on. As the action is taking

place, the potassium permanganate should be dropped carefully on the surface of the liquid mid-way between the plates. When done with care, there will be a marked motion of the colored mass toward the anode. As a control, the experiment may be repeated with the circuit open, or in reverse.

Electrolysis of Sodium Chloride Solution

A study of the preparation of chlorine by electrolysis of sodium chloride need not be limited to a diagram. This commercial preparation, in principle, can be easily demonstrated as shown in Figure 3.

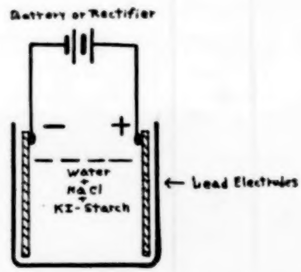


Fig. 3. Demonstrating the electrolysis of sodium chloride.

The liberated chlorine will suddenly cause the almost clear solution to turn dark blue as it liberates iodine to act on the starch. The demonstration is a good starting point for a discussion of the principles involved—including the test for chlorine.

Sulfur Dioxide as a Reducing Agent

The reducing property of sulfur dioxide can be strikingly shown in a darkened room as shown in Figure 4. A tall glass cylinder is filled with the gas; and into this is sifted some sodium peroxide. The rapid reaction, as the solid falls through the gas, will produce many flashes of light. Proof that sulfur dioxide has been oxidized can be left to the class to work out.

Watching a Solute Go into Solution

The use of fluorescent materials along with a good source of ultraviolet light (A G.E. Purple-X bulb in a small reflector makes a good and inexpensive source) opens up a whole new field of experiments that are normally difficult to show. As shown in Figure 5, when fluorescein is sifted onto the surface of a very dilute ammonia-water solution, a very interesting and colorful action can be observed as the solid dissolves and diffuses. The darker the room, the more striking will be the experiment.

PHOTOCHEMISTRY

Rather than just mentioning that silver halides are light sensitive, dip a piece of filter paper first into silver nitrate solution and then into one of sodium chloride. After spreading the paper on a square of

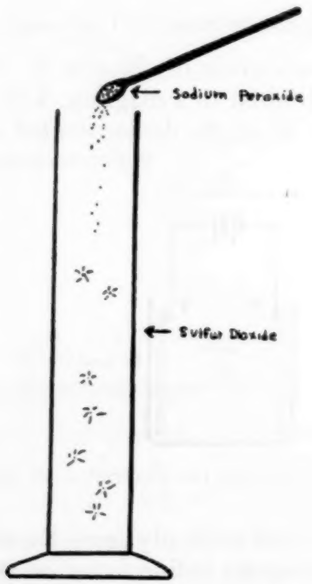


FIG. 4. Sulfur dioxide reducing sodium proxide.

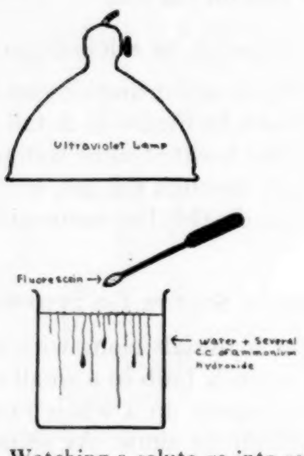


FIG. 5. Watching a solute go into solution.

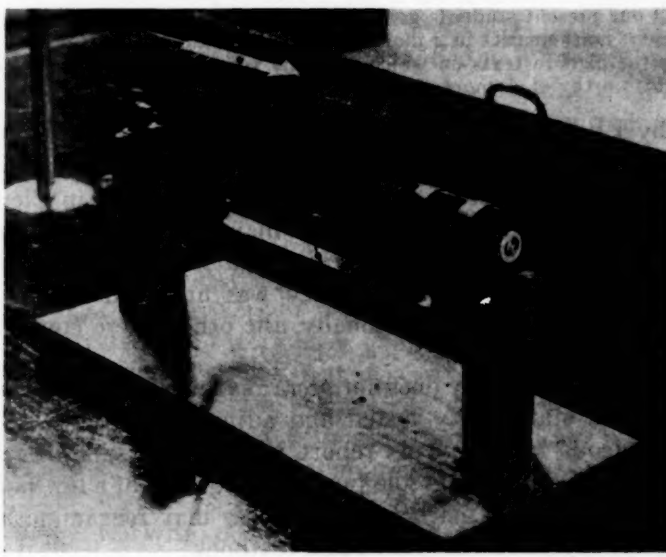
cardboard, place an opaque object on part of the surface and expose to strong light for a few minutes. After the exposed area has become darkened, remove the object and show the contrasting areas. Of

course this is very simple for members of the photography club or boys who are making blueprint paper; but not all chemistry students get around to these things.

A DEMONSTRATION ARMATURE

BROTHER GERARD
Christian Brother's High School, 6501 Clayton Road, St. Louis, Mo.

Here is a simple but useful demonstration one-turn armature that can be constructed in one day. This demonstration piece can be used very effectively in introducing the generator and motor to a physics class.



The armature consists of one turn of sixteen gauge iron, one-half inch wide. The ends are fastened to a cylindrical piece of wood. Arrows, cut from sheet metal and used to indicate the direction of the current, are mounted on both sides of the armature. By making a pair of metal rings (slip rings) to slip over the cylinder to which the armature ends are attached and by painting a black line (split ring) along the length of the cylinder, both A.C. and D.C. generator principles can be shown. The armature is then mounted on a frame which will allow it to spin freely. Painting one side of the armature red and the other blue or black will facilitate explanations and enable the largest class to see.

ARE WE TEACHING STUDENTS OR TEXTBOOKS?

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As a result of my observations of many other mathematics teachers at work and of my own experiences in teaching mathematics ranging from seventh grade arithmetic through second-year college mathematics for teachers, a number of doubts and questions have perplexed me. The most disturbing of these, however, can be grouped into four specific problems:

1. Why do so many seemingly intelligent students come into my classes with such poor mathematical backgrounds, attitudes, and work habits?
2. To what extent is mathematics, algebra in particular, taught by following a textbook page by page with nothing omitted and nothing added to adjust for individual needs, group levels, or teacher preferences.
3. Will our present students going out to be tomorrow's teachers be able to present mathematics in a more constructive manner than this?
4. Are the algebra texts on which so many teachers place so much reliance really worthy of so much influence on our courses and ways of teaching?

Finally I became sufficiently interested in these questions to conduct a study of other teachers' opinions on them. Through the cooperation of the Directing Supervisor of Mathematics in Cleveland, Ohio, the mathematics departments of many of the suburban schools surrounding Greater Cleveland, and the Superintendent of the Cuyahoga County Schools, a survey was arranged. Some of the teachers were interviewed personally, the others were contacted by letter and questionnaire.

Obviously such a study does not *prove* anything. Neither have these findings been statistically tested and adjusted for probable errors and extraneous factors. This report is merely a summary of the opinions expressed, and its sole purpose is to present a few points on which a conscientious mathematics teacher may reexamine his own philosophy, objectives, methods, and textbook.

The first portion of this study indicates quite clearly that the content of the ninth grade algebra course is often determined by the text, not by the teacher. Of the fifty-two teachers reporting, thirty-two indicate that they begin their course with a study of formulas, which in each case is the first chapter in the book. Two more begin with graphs—in one case the first chapter in the text, in the other case the second chapter, the first on formulas having been omitted. In other words thirty-three of these teachers presumably start on page one on the first day and follow through page by page with whatever the textbook presents next or the city syllabus suggests.

Now there is nothing inherently wrong with this procedure until you consider the answers given by these same teachers on the next

question. In question two, those who start with graphs and formulas are asked whether or not they find that their students are disappointed with this review of arithmetic and are impatient to start on new topics. To this, fourteen answer no, ten say yes, and two believe that they are sometimes impatient. Six say their students do not get impatient because they make this unit brief and hurry through it as fast as possible. One answers no because he presents formulas "in a new light," and the remaining one believes that the students will not be disappointed "if you use the proper selling program."

Why resort to a "selling program" to force a review of eighth grade arithmetic upon them and kill in the first two units the spark of enthusiasm and interest they may have for a new subject? They undoubtedly do need a review of all arithmetic processes, but why not review each one of them as the need for it arises when the corresponding process in algebra is introduced.

Perhaps those who answer with unqualified no's are really sincere in their belief that this is the proper approach to algebra. On the other hand, in some cases it may be merely a case of following the path of least resistance without observing the pupils' reactions to it. Nevertheless, why do those who do recognize the disadvantage of this sequence continue to start with chapter I? Why do they not use their own judgement and outline a course in which they can capitalize on pupil interest the first day and preserve it rather than deliberately kill it, then try to revive it?

Some progressive educators have gone to the extreme in letting pupil whims dictate education, but it is not necessary to reject the idea that a pupil learns better when he is interested just because it has sometimes been applied without judgement and moderation. Algebra offers at least two logical approaches that are truly characteristic of algebra—solution by equation, and signed numbers—and both units are well within the range of the average ninth grader's understanding without preliminary reviews, There is plenty of time for review of formulas when the student is ready for literal equations and is prepared to manipulate the formula and solve for any term in it, as well as merely evaluate it.

These "algebraic" approaches are being used by the remaining eighteen of the teachers contacted. The majority prefer to start with simple equations, several introduce signed numbers first, and a few begin with algebraic representation and interpretation of simple stated problems. In each case these teachers have used enough initiative to omit, rearrange, and supplement material in their text and even to deviate from their syllabus if necessary to present a course that they believe is more satisfactory for their classes.

The second section of this inquiry as to the importance of the text-

book indicates that while many of the teachers lean quite heavily on their text, few of them encourage their pupils to regard it as anything more than a collection of problem lists. The explanatory and illustrative material is seldom called to the pupil's attention. When asked in question three whether they frequently require their students to read the explanations in the text and work through the illustrations for themselves before the process is explained to the group, thirteen reply that they do, eighteen do not, nineteen do sometimes and two use this material only for assignments for superior students.

With the exception of special assignments for the above-average pupils occasionally, this procedure does not imply outside assignments on processes and problems that have not been thoroughly discussed in class. On the contrary, if the text contains suitable explanations, time should be given early in the class period for the pupils to read the explanation, work through the illustration, and reread the explanation if necessary, before the teacher's presentation is given. The teacher can then develop the class demonstration around the questions of the pupils themselves or around lead questions of his own.

Some of those who do encourage the use of their textbook explanations feel that the pupils derive greater satisfaction from doing for themselves, and others feel that the pupils will remember it longer if they work it out for themselves, but they all agree that the most important advantage of this procedure is the development of greater confidence among the students and an increase in the students' ability to help themselves when difficulties arise. They are not entirely dependent upon their memory of the explanation in class since they also have the printed explanation, with which they are equally familiar, available for reference at any time. This helps to develop independent thinking and also enables the pupils to review more effectively.

On the other hand, about one third of the teachers commenting on this procedure feel that it is a waste of time, that the pupils do not read well enough to profit from it, and that they will not bother to refer to the explanations anyway. Some of these unfavorable opinions, however, may be explained by the fact that half of all the teachers reporting feel that the explanatory material in their texts is not satisfactory for this purpose. About half of these textbook explanations are too long and complicated for the average pupil to follow, others are too general and poorly illustrated, and a few emphasize only rules without reasons.

Other comments on the texts in use are difficult to summarize meaningfully since seven different books are in use in the schools repre-

sented, and the weaknesses of one may be the strong points of another. Moreover, there seemed to be a tendency on the part of many of these teachers to accept their text without question and without having a definite opinion of their own concerning its merits and shortcomings. This was more noticeable among the city teachers who rely on the text, syllabus, and supplementary materials recommended by the planning committee than among those who select their own materials and plan their own courses.

In general, however, more than one third of the teachers contacted feel that their texts lack drill material on the basic skills and processes. About an equal number do not have enough stated problems and up-to-date applications. A few have insufficient material for the above-average student, and a few need more review material. Although a number of teachers report that their text contains no historical or biographical information, the majority of those having such material available say that they do not make any use of it.

The specific points on which these teachers feel that their texts should be improved are shown in the following lists. Over one hundred additions, omissions, and reorganizations were suggested, but these have been grouped and combined whenever possible. Some of these, of course, contradict each other and overlap, and obviously no one text could incorporate all of them, but it does make a rather exhaustive check list with which any algebra teacher can compare his own text or his own specifications for a satisfactory text.

The following *additions* to the texts in use are suggested:

1. Better explanations
   More emphasis on principles instead of mechanical methods
2. More oral drill material
3. More exercises on:

fundamentals	factoring
exponents	L. C. D.
simple equations	quadratics
literal equations	stated problems
evaluation	systems by graphs
removing parentheses	dependence and variation

   equations with negative roots
4. A good chapter introduction on applications of algebra
   More modern photographic illustrations
   More stated problems showing applications to other subjects and fields
   Better preparation for stated problems—algebraic representation
5. More problems based on geometric applications
   More emphasis on principles needed in geometry—axioms, ratio, etc.
6. Exercises should be more carefully graded as to difficulty
7. Short-cuts as transposition and cancellation should be taught after the principles are understood
8. Solution problems, irrational equations, and factoring of cubes should be included
9. More review material:
   chapter summaries

review lists including all kinds of problems
remedial problems
review tests and better balanced tests
review material to fill up half pages at end of topics so that new topics will start at top of page

10. Supplementary, review, and extra assignment material at back of book
11. Supplementary reviews and tests in booklet separate from text
12. Answers to part of problems for pupil self-check

The following *omissions* are suggested:

1. Omit review of arithmetic
2. Omit statistical graphs
3. Omit extracurricular material for enrichment
4. Omit ratio and proportion
5. Omit trigonometry
6. Omit explanations—give only a few models
7. Fewer "interest pictures and puzzles"
8. Fewer long complicated fractions and factoring problems
9. Less emphasis on linear systems
10. Omit from lists of simultaneous equations to be solved by substitution those with large coefficients that make substitution impractical
11. Omit from lists of stated problems to be solved by simultaneous equations those that can be very easily solved with one equation

In brief this survey indicates:

1. Many of us are allowing our text to determine the nature of our course instead of the needs and interests of our pupils.
2. Lack of suitable textbook material and time causes many of us to dictate rules or hurriedly demonstrate new processes instead of encouraging the pupil to read explanations and think through new situations for himself first.
3. Many of us are dissatisfied with the text we are using. We need a great deal more and better material. Yet we have not taken the trouble to formulate clearly in our own minds exactly what we want and how we want it presented. Why not think this problem over and discuss it with the next publishing company representative who comes to your school.

JET FUEL CAN BE EXTRACTED FROM OIL SHALE

Billions of barrels of jet engine fuel, for a possible wartime emergency, can be extracted from the oil shales of Colorado, Dr. J. D. Lankford of the U. S. Bureau of Mines stated.

He estimated that 88% of the crude shale oil could be converted into a hydrogenated product containing a premium diesel oil and a high-quality jet fuel practically free of sulfur, oxygen and nitrogen compounds. Costs of such extractions have not yet been definitely determined.

Sensitized fabrics, from silks to canvas, are obtained with a special chemical preparation and, after treatment, may be printed with a photograph. The dried sensitized cloth is printed and washed just as commercial enlarging paper is handled.

U AND I AND YOU AND I

JAMES B. DAVIS

Lower Merion Senior High School, Ardmore, Pa.

It is no sin to be ignorant, but to remain so is a different matter. In this disturbing age of A- and H-bombs, You and I should be deeply concerned with the many associated implications. "A little learning is a dangerous thing," said Pope in his "An Essay on Criticism," yet at least a little learning would make for bridge table chit chat and would be ideal for a drawing room bull session, both of which may lead to further enlightenment, so that the suggested danger may be eliminated.

Top drawer scientists play the parts in the scientific and technological drama of the U and the I phase of the bomb, while it is You and I, relatively ordinary laymen, who will have to interpret the lines, in the many and involved social aspects of these weapons. Let me explain what I mean by the U and the I factors:

The H-bomb is produced by a process known as fUsion, while the A-bomb is brought about by fIssion.

FUSION is the transmutation of hydrogen into another element, helium, under conditions of extreme heat and pressure. The sun's energy is generated by this process, commonly called the hydrogen-to-helium cycle. It is illustrated by the following diagram:

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Hydrogen+a neutron                Tritium+a proton
                ↓                      ↑      ↓
(1 proton)    Heavy hydrogen+a neutron     Helium
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FISSION is the splitting of the nucleus of an atom by capturing a neutron. Illustrated by Uranium-235.

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                                 Barium
                               ↗
Uranium-235+a neutron                    +4 neutrons
                               ↘
                                 Krypton
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In our quest for more than just a little learning, it would seem desirable to investigate the field of physics, modestly. Let's look at a few concepts: The work "NUCLEAR," with just a slight juggling of letters, becomes "UNCLEAR." Is it because the description may be unclear that the terms "A-bomb" and "Atomic Energy" are used rather than "Nuclear Bomb" and "Nuclear Energy"? Is it easier for the ordinary layman to know the H-bomb as the Hydrogen Bomb," while the topflight physicist refers to it as a "Tritium Bomb"? After all, the best terminology to use is the one that will be best understood. Most doctors would rather not tell a patient he had "Dermatomycosis

Pedis" when "Athlete's Foot" would convey the meaning. Neverthe less, the alert man of the street may find it easier to understand the basic physical differences of these dreaded weapons by remembering the U and I factors, fusion and fission.

But YOU and I, all of us, are involved in a consideration of the social factors whether we wish to be or not. When we stop to consider that an A-bomb could wipe out an area of 0.5 square mile and that an H-bomb would destroy an area 50 miles square, YOU and I become pretty vividly framed in the whole picture of nuclear energy. What shall we do about it? It is not the way of Science to ignore it. Let's look at the problem in terms of human development. Man was afraid of fire, but by vigilance, learned to control it for his own welfare. Dynamite was held in an awesome light, until Man through study and control, turned its energy into useful channels. The minds of men, who learned to control fire and dynamite, were no better than the minds of men today. So it would seem that YOU and I, in order to be worthy to stay in the picture, indeed to stay in the picture worthy or not, must be crusaders for an informed and enlightened people. Can we not strive, all of us, to translate Einstein's equation from its scientific form and meaning—

$$E=MC^2$$

into a social one, such as:

$$E=M \quad \times \quad C^2$$

$$\text{Education}=\text{Man}\times\begin{cases}\text{Common Sense}\\ \text{Common Decency.}\end{cases}$$

Could we not start a chain reaction for the common good—using the Golden Rule as our neutrons and build a stock pile of Good Will, rather than bombs? YOU and I must give the answer.

MORE FUN AND MATHEMATICS

The Institute for Teachers of Mathematics sponsored by The Association of Teachers of Mathematics in New England will be held this year at Tufts College, Medford, Massachusetts. Beautiful campus, fine accommodations, excellent facilities. Eight days (August 22 through 29, 1950).

The program will be similar to the one which was so highly successful last year, and will again include speakers on the latest developments in pure mathematics, and others on applications of mathematics by leading mathematicians from college faculties, business, research, government agencies, and industry. There will also be discussion groups on methods of teaching and an abundance of recreation—interesting profitable, enjoyable.

For details drop a card to Janet S. Height, Wakefield High School, Wakefield, Massachusetts; or Albert Norris, Milton Academy, Milton, Massachusetts.

DEVELOPMENT OF A JUNIOR COLLEGE MATHEMATICS PROGRAM FOR NON-SCIENCE, NON-MATHEMATICS MAJORS[1]

HAROLD E. STURM
Waterville Consolidated School, Waterville, Iowa

INTRODUCTION

The following summary of the panel discussion on "Development of a Junior College Mathematics Program for Non-Science, Non-Mathematics Majors" is divided into two parts. The first part deals with various curriculum studies in the area mentioned and was presented by Dr. Fry. The second part deals with new approaches to this area of mathematics as exhibited in new "unpublished" texts and new published textbooks and was presented by Dr. Jones.

THE PLACE OF MATHEMATICS IN THE CURRICULA OF THE NON-SCIENCE, NON-MATHEMATICS STUDENT

During and immediately following the war years, many colleges and universities in this country examined their programs to determine the extent to which the curricula met the vocational and cultural needs of the student. The traditional curricula were examined in the light of minimum needs for: (1) competence and understanding in some vocation; (2) effective citizenship and participation in a modern democratic society; (3) appreciation of the background of the physical, biological and social sciences in order to read and converse intelligently on current events and problems.

Many of the curriculum and planning committees were in accord in a belief that:

1. Mathematics is of great value and importance in the modern world.
2. Greater efficiency in the learning and teaching of mathematics would result from a clearer understanding of its vocational and cultural uses.
3. Mathematics has value for students who are not likely to make explicit use of mathematics.
4. Mathematics can contribute to the training for careers which do not make use of mathematics.
5. A basic knowledge of mathematics would lead to a better appreciation of the scientific age in which we live.
6. Mathematics is an important means of enlarging and extending mental and cultural horizons of students.

It seems evident that all persons should have an understanding of mathematics which will make them competent to use the mathe-

[1] A summary of a panel discussion by Dr. Cleota Fry, Department of Mathematics, Purdue University, and Dr. Phillip S. Jones, Department of Mathematics, University of Michigan, at the Junior College section of the CASMT convention held at Chicago, November 25, 1949. Reported by the Secretary of the Junior College Section.

matics necessary in the ordinary pursuits of life. Some persons, however, need a much broader background for preparation for certain professions. Therefore, it is generally agreed that two types of curricula in mathematics are needed. One curriculum would comprise the traditional courses in mathematics which are designed to prepare students for careers in mathematics, astronomy, physics, meteorology, chemistry, actuarial work, and allied fields. The other curriculum would contain a course in mathematics which would meet the minimum needs of courses in other fields, in preparation for careers for which the need of mathematics is not so extensive, and in the ordinary pursuits of life. This mathematics course would be designed for students preparing for careers in commerce, finance, business administration, public accounting, economics and social science, elementary military and naval science, office work, biological science, medicine, dentistry, pharmacy, nursing, geological science, and other allied fields.

Some mention should be made of the need for mathematics in careers which do not make extensive use of mathematics. Some institutions have not required majors in these fields to take a course in mathematics, while other institutions have required a one year course in mathematics, which is usually the traditional type in which a considerable amount of time is spent in learning and perfecting techniques necessary for further study in mathematics. There is considerable basis for believing that a change should be made in both types of institutions.

Past research seems to indicate that colleges and universities which do not require mathematics of all their students should require some mathematics at the college level. In a vocational sense, recent studies have indicated that students having vocational majors which are usually considered non-mathematical actually do have need for minimum mathematical knowledge in preparing for and carrying out their careers. Specific reference is made to the results of a careful study of minimum mathematical needs made by the U. S. Army during World War II. Army jobs utilizing mathematics were studied and their requirements were used as a basis for defining minimum mathematical needs. These results were included in the "Report of the Commission on Post-War Plans of the National Council of Teachers of Mathematics."

In addition to the minimum mathematical requirements for vocational competence, serious consideration should be given to the "gap" left in the cultural development of the student if he is left without some understanding of the development of mathematics as a part of the development of our civilization. The student should also

gain some idea of the role of mathematics in our over-all cultural pattern.

In some institutions having required courses in mathematics, the trend of thought is that part of the student's time which has been used for developing techniques employed in higher mathematics (i.e., extensive work in trigonometric identities; breaking a fraction into partial fractions, etc.) should be used to better advantage. Many faculty members of such institutions feel that the over-all development of the student will gain by deleting such portions of the traditional course and substituting treatment designed to give a sound application to the concepts of mathematics and cultural knowledge of the subject. Many educators feel that the cultural development and basic concepts of mathematics are so important that their treatment should be included in the curricula leading to careers making extensive use of mathematics.

As an example of a mathematics course designed for the non-science, non-mathematics student, Dr. Fry cited a course now in use at Purdue University. The course, entitled "Concepts of Mathematics," is a 3 semester-hour, 3 recitations per week course. The course, which is a required course for all freshmen students is outlined briefly below:

Math. 21

CONCEPTS OF MATHEMATICS

3 semester hours — 3 recitations per week

Text—Mimeographed notes by W. L. Ayres, C. G. Fry, H. F. S. Jonah

First Semester

I. Constants and Variables
II. Charts and Graphs
III. Functions
IV. Analytic Geometry
  1. Cartesian rectangular coordinate system
  2. Distance between two points
  3. Straight lines
  4. Parabolas
V. Percentage, Ratio, Proportion and Variation
VI. Algebra
  1. Linear equations
  2. Quadratic equations
VII. Simple Finance
  1. Simple interest
  2. Compound interest
  3. Amortization of debts
VIII. Trigonometry
  1. Graphical solution of triangles
  2. Right triangles
    a. Special
    b. General
  3. Obtuse triangles
  4. Sine and cosine functions

Second Semester (tentative)

I. Probability
II. Elementary Statistics
III. Introduction into some of the Elementary Phases of Advanced Mathematics
   1. Topology
   2. Number theory
   3. Non-Euclidean geometry
   4. Logic
   5. Famous unvolved problems.

Experimental Courses and Texts for Non-Science, Non-Mathematics Students

Current experimentation in the field of courses for non-science, non-mathematics majors is reflected in recent experimental texts. The recent "unpublished" texts seem to fall into about 3 categories. However, it must be emphasized that categorizing the books quickly and completely is not entirely fair. No book fits exclusively into one category. Further, there is no intent to review or evaluate the books implied by any of the things said, or by listing or failing to list the work of any author.

The first group, however, may be roughly classified as texts emphasizing postulational procedures and the logical structure of mathematics in some detail. Examples of this type of "unpublished" text are *Mathematics I*,[2] *An Introduction to Mathematical Thought*,[3] and *Fundamental Mathematics*.[4]

The second group of texts are those whose nature is more of a survey of classical topics organized in a "fused" fashion, sometimes with less rigor, usually with less detail than in the ordinary presentation of trigonometry, college algebra, analytic geometry and calculus. *An Insight Into Mathematics*[5] and *Freshman Mathematics*[6] are examples of this type. Both of these are also "unpublished."

The third type of text stresses "competence" in elementary topics, some going back so far as to present drill in arithmetic and fairly elementary discussions of ratio, proportion, and per cent. *Basic Mathematics for General Education*,[7] to be published in expanded form by Prentice-Hall Inc. is an example, as is the text, *Basic Mathematics, A Workbook*.[8]

A fourth type of course represented by several published texts

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[2] Jacoby, Robb and Meyer, Herman, *Mathematics I*. Coral Gables, Florida: University of Miami, 1949.

[3] Stabler, E. R., *An Introduction to Mathematical Thought*. Hempstead, New York: Hofstra College, 1948.

[4] Northrop, E. P., *Fundamental Mathematics*. University of Chicago Book Store. (2nd. ed. 1946). The College Mathematics Staff (Universtiy of Chicago) *Fundamental Mathematics*, (3rd ed., 1948, 1949).

[5] Kaltenborn, H. S., *An Insight Into Mathematics*. Memphis, Tennessee: Memphis State College, 1949.

[6] Theobald, John A., *Freshman Mathematics*. Dubuque, Iowa: Loras College, 1946.

[7] Trimble, H. C., Bolser, F. C., Wade, T. L., Jr., *Basic Mathematics for General Education*. Tallahassee, Florida: Florida State University, 1948.

[8] Keller, M. W. and Zant, James H., *Basic Mathematics, A Workbook*. Boston: Houghton, Mifflin Co., 1948

may be termed a "cultural" approach in which discussions of interesting concepts, themes and problems from modern mathematics are mingled with varying amounts of classical topics, drill and manipulation. An example of this type is ***Introduction to Mathematics***,[9] of which a second edition has just been published.

A fifth type of organization which has been approached in at least one published text and is being considered for at least two new courses lays considerable emphasis upon the historical development of mathematics. Two published texts of this type are ***Mathematics, A Historical Development***,[10] and ***Mathematics in Human Affairs***[11] although there is no book which has gone "all-out" for either an historical organization or content.

As was previously stated, the above classifications are broad, and no book fits exclusively into one category. Also, there is no intent to review or evaluate the books implied by any of the things said or by listing or failing to list the work of any author.

According to Dr. Jones, "At the University of Michigan, graduation requirements which are new this year will require every student in the College of Literature, Science and the Arts to complete one year of either mathematics or philosophy. The purpose was to require that each student should have some experience with abstract thought. Our faculty thinks such an experience should be a part of general education on the college level. As a result, we are offering a new freshman mathematics course for non-science, non-mathematics majors which emphasizes logical and 'cultural' phases of mathematics."

"I believe it is too soon to say which, if any, of the five types of organization will become an accepted pattern for mathematics courses in the future. I do believe that some course designed for the non-science, non-mathematics majors is needed and will in time become an accepted thing. Its objectives and procedures need definition, study, experimentation and clarification," Dr. Jones concluded.

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[9] Cooley, H. R., Gans, D., Kline, M., Wahlert, E., ***Introduction to Mathematics***. Boston: Houghton, Mifflin Co. (2nd ed. 1949.)

[10] Boyer, L. E., ***Mathematics, A Historical Development***. New York: Henry Holt & Co.

[11] Kokomoor, F. W., ***Mathematics in Human Affairs***. New York: Prentice-Hall Inc., 1942.

School Science and Mathematics is owned and operated by the Central Association of Science and Mathematics Teachers. One chapter in the anniversary publication, *A Half Century of Teaching Science and Mathematics* tells the history of this organization.

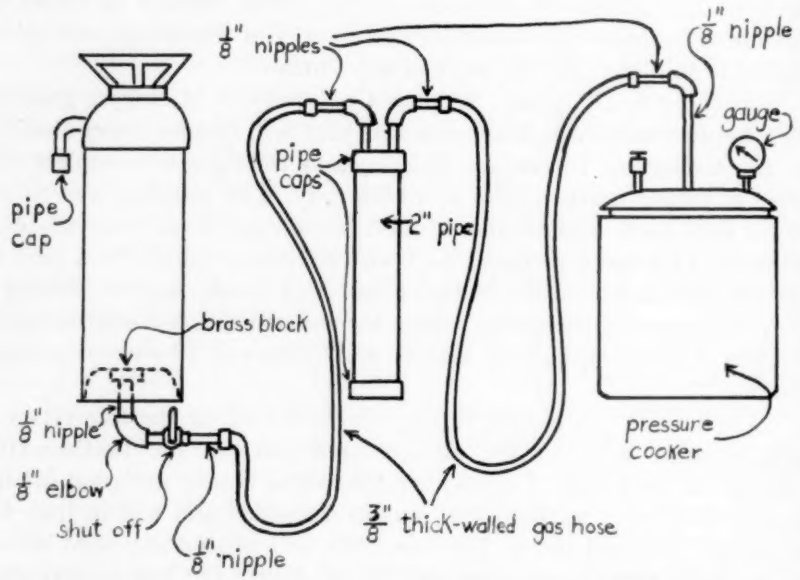
Ladder platform provides a comfortable resting place for the feet of a worker forced to stand for an extended period on the ladder. It has a front edge fashioned to fit over one rung while its rear edge is suspended by arms from the rung above.

LET'S MAKE POP

BENJAMIN H. STASCH
Corning Free Academy, Corning, N. Y.

"Carbon dioxide is a dense gas heavier than air and readily soluble in water. It neither burns nor supports combustion. It combines with other substances to form carbonates."

When this statement is made to pupils without experimental corroboration it goes into one ear and out of the other, leaving the usual blank space between. To produce gratifying visual and gustatory evidence as to its solubility, a simple and inexpensive pop making apparatus can be made.



After you have discharged a soda-acid fire extinguisher for the pupils and have taken it apart to show them its construction, unscrew the hose and close the outlet with a pipe cap. Through the end of the tank opposite the mouth, drill a $\frac{3}{8}''$ hole, scrape the copper around the hole bright, flux around the hole with zinc chloride and coat it with solder. Make a brass or bronze block about $\frac{3}{4}''$D and about $\frac{3}{8}''$ thick with a $\frac{1}{8}''$ pipe tapped hole in the center. Screw a 3″ long galvanized nipple into the tapped hole, coat the edges and the under side of the block with solder and solder the block over the hole in the bottom of the tank. Finish the apparatus as shown in the diagram. For the shut-off cock use a $\frac{1}{8}''$ male-female quick opening cock. Use $\frac{1}{8}''$ galvanized nipples and elbows throughout.

The trap may be set upright in any suitable wooden frame. It will catch anything that fizzes through from the generator.

If your cooker gauge will not register 30 lbs., replace it with one that will. (Price between $1 and $2.) The cooker will safely stand that pressure, and the higher the pressure the stronger the pop. The 10 qt. cooker is suitable for a class of 35. The safety valve may be removed to receive the $\frac{1}{8}'' \times 6''$ nipple.

All pipe threads must be coated with paint, preferably asphaltum. Twist soft annealed baling wire (#14) around the hose ends. Hose clamps are even better. The hoses should be about 4 ft. long to allow plenty of play during operation.

To operate, put into the cooker 3 packages of Flavorade (orange seems to be the most popular), $1\frac{1}{2}$ lbs. sugar and add enough ice cold water to make 9 quarts. Add a few ice cubes. Stir up throughly from the bottom. Clamp the cooker cover on and leave the relief cock open. Close the shut-off cock under the fire extinguisher and put in the usual amount of water with $\frac{1}{2}$ lb. bicarbonate of soda. Pour in about $\frac{1}{2}$ teaspoon H_2SO_4 so that some CO_2 will rise and drive out the air. Put in the acid bottle containing $\frac{1}{3}$ to $\frac{1}{2}$ the usual amount of acid and screw the cover on. Invert the tank and then open the shut-off cock a very little so that some CO_2 will drive the air out of the hoses, trap and cooker through the relief cock. Close the relief cock and then run the pressure up to 25 lbs. Pick up the cooker and shake it violently. The gauge hand will drop back about 5 lbs.

"Where did the gas go?" you ask.

"Into the water" your class choruses.

They are with you. Even the dullest is on the alert now.

"It has done what in the water?" you ask.

"It has dissolved," several will answer.

You run the pressure up to 25 lbs. again, shake and repeat the operation until it stays put at 25.

"Why doesn't it drop back any more?" you ask.

"The water is holding all the gas it can," one of the brighter pupils answers.

"Then you say the water is what?" you ask. No answer.

"When a piece of cloth is soaked with water so that it can hold no more you say the cloth is what?" you ask.

"Saturated," they chorus.

Now you gather them around the table, let off the excess gas through the relief cock and open the cooker. The pop is fizzing and you explain that when the pressure is reduced some of the CO_2 comes out of solution. You put the cooker cover over a large beaker with the $\frac{1}{8}'' \times 6''$ nipple pointing into the beaker, open the shut-off cock and fill the beaker with CO_2. Then you ask a pupil to tip

back his head and open his mouth. When you pour the gas down his throat he and the other pupils are delighted. Now they will all want a dry drink. You should have an open kettle of boiling water ready to scald drinking cups if you haven't enough paper cups to go around. The party is on.

When you take the apparatus apart rinse out the shut-off cock. Screw a brass pipe plug into the block at the end of the extinguisher and reload.

This is one of the richest and best remembered experiments in the general science course. After 15 years, former pupils still ask, "Are you making pop this year?"

"Does the pop hold the gas very long?" a teacher asked.

It always disappeared so fast that we never did find out.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS—TWELFTH SUMMER CONFERENCE

University of Connecticut, Storrs, Connecticut, August 21–26, 1950

Many science teachers and industrial scientists will be interested in this preliminary announcement of the Twelfth Summer Conference of the New Engand Association of Chemistry Teachers. This well known organization is composed of over 500 members. About one half are secondary school teachers and half college professors, with a few students and industrial scientists. They will meet with about 100 non-members August 21–26, 1950 at University of Connecticut, Storrs, Connecticut.

Some of the topics to be presented by outstanding speakers from many parts of the country include: Electrochemistry in the Freshman Course; Chemistry Applied to Archaeology; Chemical Problems of the Frozen Foods Industry; Panorama of Steel; Plant Hormones in Practice; University Service to Industry; Modern Chemistry in Amino Acid Synthesis; Crystallization and Crystal Growth; Micro-chemistry; Isotopes; Recent Advances in Fluorine Chemistry; Medical Aspects of the Atomic Bomb; and other topics still being arranged. In all over sixteen talks and demonstrations will be presented. This is an ideal opportunity for all teachers young and old to acquire scientific information and teaching methods in a pleasant vacation atmosphere. Each year teachers come from far outside New England to participate in these conferences. Many bring the family because of the friendly spirit of the whole gathering. All are invited.

Registration and college hostelry fees are very reasonable. Recreational facilities are numerous and nearby. The conferences are always practical and there is ample time for private discussion with more experienced teachers or professional men and women.

Anyone desiring more information should write now to the Secretary of the Summer Conference, Mr. Carl P. Swinnerton, Pomfret School, Pomfret, Conn. The complete program with descriptive information will be available from him without obligation by June first.

Inner tube for automobile tires, made with nylon cord for reinforcement, will outwear as many as three sets of tires, it is claimed. In event of a puncture, the nylon construction squeezes rubber around the puncturing object, thereby preventing sudden flats and permitting only slow leakage.

AN ELEMENTARY SUPERVISOR LOOKS AT ARITHMETIC

SISTER M. BERNADETTA
St. Brendan School, Chicago, Ill.

There is no getting around the fact that many—too many—of the boys and girls in our classes come to us bored and indifferent to arithmetic and in some cases actually detesting it. Typical comments are "It is too hard" or "I just do not like it." Why is it too hard? Why do they dislike it? Surely, there is something we can do to help them to eliminate their feeling of anxiety, their lack of certainty, their expectation of failure. How can we save these young people who otherwise may grow up using arithmetic only when they are driven to it? Obviously, it is our responsibility as teachers of arithmetic to make this subject understandable, interesting, challenging, and socialized.

According to reliable statistics, there are more failures in arithmetic than in any other school subject. Moreover, the further children progress through the grades the greater the difficulty they experience with this subject. What is the explanation? Definitely it is weaknesses in arithmetical learning in the primary grades. If the teacher directs adequately, lights the way, and guides the growth, the children will naturally respond and correctly comprehend. It is in the lower grades that the child develops his attitude toward arithmetic, and forms his habit of thinking of numbers. These habits once formed and then strengthened by use, very largely set the limits of his success in later learning. Progress is dependent upon many factors of which individual pupil ability and the skill of the teacher are the most prominent. Skill in arithmetic is a process of growth. Each stage in the development grows out of the previous stages. If there is a lack of mastery in any stage, the pupils are unable to carry on in the next stage. Teachers must assume the task of correcting deficiencies as well as of teaching new work.

Arithmetic should not be allowed to be made difficult or distasteful to the pupil. Its importance cannot be overestimated, and the pupil should be brought to realize early in his school life that he needs to know certain facts about number and number relations, and that the acquisition of this information is easy and interesting. The applications of the principles of arithmetic are an emphasis on exact understanding, on correct interpretation, on logical thinking, and on correct results that should be an invaluable asset to the pupil's procedure in solving many other problems that confront him.

Learning is an individual process and does not result from present-

day mass teaching. A wide variation of ability exists among pupils in all classrooms and unfortunately we often fail to recognize these individual variations as we proceed with mass teaching. The failure to adjust teaching procedures to meet the different learning abilities and rates of learning which exist among children causes many cases of unnecessary retardation. Teachers waste time and effort trying to teach new subject matter to a child who has failed in an earlier grade to master the skills necessary for an understanding of the situation at hand. The children waste time and get discouraged as they try to comprehend but lack the foundation experience necessary to such understandings.

Undoubtedly, one of the most difficult and perplexing problems faced by the arithmetic teacher is how to provide for the wide range of differences among the individuals in her class. Individuals differ in the following respects: (1) mental ability (2) in the level of their mastery of number operations (3) in the rates at which they learn (4) in their readiness for new work (5) in their interests (6) in the kind of difficulties they encounter (7) in their responsiveness to corrective and remedial measures the teacher may try to apply (8) and in many other ways. There are those who appear to believe that the expression individualization of instruction implies that instruction must be so organized that each individual works by himself on a specific task, not as a part of a group. This is an erroneous conception of the meaning of individualization. Certain capacities of the individual are stimulated by association with others, such as creativeness, leadership, and initiative.

In order to make the arithmetic program effective, the teacher should know much about her pupils: (1) their needs (2) their interests (3) level of mental ability (4) special aptitudes and talents (5) degrees of skill (6) social qualities (7) background of experience. On the basis of such information an arithmetic program can be planned and conducted that is much more likely to bring about general growth, as well as the development of strictly individual capacities, than would be the case under a program of activities haphazardly chosen and arbitrarily assigned by a teacher unaware of individual differences.

The textbook and the course of study affect the quality of arithmetic instruction, but the teacher exercises far greater influence in this respect. It is a truism that the finest course of study and the finest text in the hands of the poor teacher accomplish nothing, and conversely, the poorest course of study and the poorest text in the hands of the good teacher accomplish astonishingly satisfactory results. Perhaps the most powerful single determinant of success is the teacher's point of view with regard to the nature and purpose of arithmetic. She adopts one of three distinct views. Probably the most

popular today is still to regard it as a drill subject. There are indications that this view is less commonly held now than say, twenty-five years ago, but there is plenty of evidence that it is still popular. For example it is a common practice in courses of study to classify arithmetic as a drill subject, or a skill subject. The popularity of this view is also seen in many classroom activities such as unguided drill with workbooks, in professional books and articles on the teaching of arithmetic, and in the organization of textbooks themselves. In the extreme form of this view, arithmetic is looked upon as a body of separate items to be mastered. Thus the combinations are memorized in isolation, column addition is taught by telling the child what to do, training in multiplication consists in furnishing the child a list of steps in the process, and then mechanically teaching him these steps, the division of fractions is mastered through the memorization of appropriate rules and so on. In a word, the drill theory reduces to a minimum the meaning of numbers. It puts a premium on repetition. It holds that through saying facts over and over and through practicing processes again and again, the child learns all that he needs to know about arithmetic. Drill does not make one intelligent in any kind of activity. If the child seems to learn his facts and processes, it is only because he has deserted repetition for some other more meaningful way of conceiving of the facts and processes. Probably the upper fourth of the class will resort independently to the meaningful approach. THE SHORTCOMINGS OF THE DRILL THEORY CANNOT BE FULLY ELABORATED IN A SHORT TIME. It is enough if we secure a fairly clear idea of it, are able to identify its presence in instructional procedures, and are made somewhat critical of its worth as the sole form of teaching arithmetic.

It was natural that there should be a reaction against the teaching of arithmetic by the drill theory. This reaction has actually taken place. As a part of it there has appeared in the last few decades a tendency to reserve systematic arithmetic instruction until the third or even the fourth grade. The principal reasons for this theory are: (1) children when they come to school know no arithmetic and require none to satisfy their needs (2) arithmetic is too difficult for the children in the primary grades, and to teach it is to violate their very nature (3) whether or not children know or need arithmetic is beside the point; let them pick up arithmetic in an incidental way as they experience number in the situations in which they naturally find themselves. The theory of teaching arithmetic through incidental experiences fails to recognize certain important factors regarding the nature and growth of arithmetical ability. If the purpose of arithmetic is to develop intelligent use of numbers and expert forms of quantitative thinking, then the child left largely to his own devices is hardly likely to become skilled in arithmetic. Arithmetic is not correctly

understood unless it is viewed as a system of thinking, and it is not properly taught unless it is approached as a system of thinking. Instruction which relies upon incidental learning neglects this essential feature of arithmetic.

The meaning theory regards arithmetic as a system of meanings. It calls for consistent emphasis upon understandings, upon relationships, and upon the intelligent use of number. The meaning theory is the correct approach. Arithmetic is a system of meanings—numerical meanings and social meanings. The child knows arithmetic not only when he can figure acceptably, but when he is intelligent in quantitative situations. He must be able to solve number problems not only as they appear in the textbooks, but also as they appear in the school and in his life outside of school. The meaning theory represents a sincere attempt to make arithmetic sensible to children, to point out the constant need for it, and the innumerable uses of number in daily living. To be meaningful the arithmetic problems the child is asked to solve must be related to life. Problems which have to do with family living cannot but develop arithmetical understandings. To attain this end, therefore, instruction must be systematic, organized and purposeful.

The two extremes in the teaching of arithmetic are today being discarded: the old drill method because it neglects meanings, and the incidental method because it neglects system. By far the prevailing trend today is in the placing of emphasis upon a meaningful, systematic procedure according to a pre-planned outline. Definite stages in the child's progress in numbers experiences must be recognized.

For a pupil to use numbers intelligently, he must be aware of its existence whenever it appears. This awareness calls for continued growth in the knowledge (1) of number concepts, (2) of the ways numbers are related to each other, (3) of the recognition of the situations which involve arithmetical principles applicable to daily living, (4) of the ability to use numbers in situations requiring their need.

What are the basic objectives in teaching arithmetic?

1. To give pupils an understanding as well as an appreciation of the meaning of number concepts.
2. To simplify the teaching and the learning processes involved.
3. To raise abilities in both fundamentals and problem solving.

How are these objectives achieved in order to give the child opportunity for success—thus building up confidence? Children are people. With them as with us, nothing succeeds like success.

1. Definite initial learning.
2. Much easy practice
3. Problem material based on real experiences—natural social situations.
4. Unit organization of materials.
5. Tests in both fundamentals and problem solving.
6. Cumulative self-tests and reviews for pupil evaluation.

What results are assured?

1. Clear understanding of number and number concepts.
2. Improved ability in both fundamentals and problem solving.
3. Prevention of weaknesses rather than provision for remedies.
4. Elimination of pupil fear, fatigue, and failure.

What plan is followed?—The FOUR-POINT procedure in the summary of each unit:

1. Point One—List of arithmetical skills and concepts that should be mastered.
2. Point Two—Diagnostic tests to find out whether or not material has been understood.
3. Point Three—Remedial practice if not understood.
4. Point Four—Improvement test after remedial work has been done.

At the end of the year take inventory of what has been learned under two headings:

1. Skill in computation.
2. Skill in problem solving.

Textbooks of necessity cannot provide for different rates of learning, and the conscientious teacher attempts to meet the situation through the use of supplementary materials. To be effective aids in teaching and learning, the supplementary material should make the following contributions to the program:

1. Locate definitely the point where a pupil has failed to attain mastery of a fundamental skill.
2. Direct the child's attention to the specific cause of his trouble and lead him to desire self-improvement.
3. Assist the teacher in organizing her program of instruction to meet the needs of individual pupils.
4. Supply the pupil with materials which are keyed to his needs and scaled to his level of ability.
5. Provide the teacher and the pupil with tests for measuring improvement.

Such a program will focus attention upon the needs of the individual pupil and will prevent much of the unnecessary retardation which now results from regimented instruction. Good supplementary material diagnoses the abilities of pupils, directs remedial instruction, maintains skills, encourages pupil self-appraisal, measures pupil achievement.

Visual Aids should become an integral part of arithmetical teaching. The addition of visual aids supplements the teaching and clears up doubts still existing in the minds of the pupils. This type of valuable program gives each child the opportunity of drawing on knowledge already digested, and of clearing up doubts that previous classroom work had not completely erased. Encourage a complete and well-knit program of visual aids. No organization of educational materials can substitute for good teaching but the use of better materials

can result in more effective learning. Audio-visual education is as timely and as permanent as the airplane or the radio, and its place in education cannot be ignored.

In a film entitled MEASUREMENT the child finds that from the moment he gets out of bed, the pattern of his live is interwoven with measurement. Time, temperature, liquid measure, weight, cubic, square and linear measure permeate the fabric of society. The illustrations he encounters are simple ones, but they explain and highlight the importance of measure.*

Whatever genuine teaching of arithmetic that is done in our schools must be done by the teachers. What constitutes the teaching of arithmetic? Is the teacher really teaching who, after presenting the textbooks material, simply insists that the children drill until the answers are accurate? Is the teacher actually teaching who merely explains the examples in terms of her own adult understanding of the number system? Teaching arithmetic involves the analysis of the mental processes of the pupil who is working with fundamental operations. Arithmetic must be taught in terms of the pupil, not simply in terms of the subject matter itself, and not until teachers understand intimately the nature of the difficulties which children encounter in arithmetic can the school expect very much change in the high percentage of failures in this subject. As for the teaching itself: the only safe way is to assume nothing, that is explain everything fully and completely, using objects, pictures, diagrams, every possible means of concreting the new idea. Unless the teacher's teaching results in the pupil's learning, it is not an educational force. Unless the pupil's mind is stimulated to self-activity, he will not learn. All the teaching in the world is a waste of time if it does not deepen the child's understandings, attitudes, and habits. It must be full of meaning for the child. The education process is effective only if it sets the child thinking. Let us ask ourselves again just what we want to make arithmetic become for the children looking up at us from the desks in our classrooms. Not, we say emphatically, a meaningless chore; not a worry or a burden or a source of confusion; but something stimulating, creative, something they feel at home with and confident of understanding. Building the

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* Films dealing with Arithmetic may be rented from the following places:

American Film Registry
28 East Jackson Boulevard
Chicago 4, Illinois

Loyola Educational Film Library
Loyola University
Chicago 26, Illinois

Encyclopaedia Britannica Films Inc.
Wilmette, Illinois

foundation for this kind of experience with arithmetic is in our hands. Let us meet the challenge.

What is expected of each child from grade one through grade eight?

The following plan is an over-all picture of what can be accomplished.

The child in the *first grade* should have many interesting number experiences. Counting, grouping, working with objects and numbers, using money, estimating size and quantity are number activities in which children of this age normally engage. Progress in number growth is gradual and continuous. Mental arithmetic, thinking about real problems, is stressed. The need for number arises in social situations with the school and classroom groups. In these situations honesty in the use of money should be taught.

Numerous concrete and meaningful experiences in *second grade* give the child an understanding of number relations. While many understandings of the first grade are repeated here, they assume deeper significance with new experiences. Number concepts are broadened, automatic response to number processes is improved, and the ability to apply these facts to the solution of everyday problems is increased. As a first step in the *second grade*, the teacher should take an inventory of each child's abilities and help him to make continual progress.

In the *third grade* the child begins to see that there is economy of time and effort in mastering the fundamental facts. The teacher should know the amount of arithmetic knowledge already acquired by each child and help him to progress gradually. At this period the textbook is introduced as an aid to the child in his work with numbers. While comprehension is given first consideration, the child is encouraged to respond automatically as well as accurately in those number processes already developed. At all times the child is helped to apply his number knowledge to everyday living.

In the *fourth grade* special emphasis is placed on learning to read materials and to develop efficient habits of problem solving. Many practical classroom situations will give meaning to the use of arithmetical processes. The child continues to strengthen habits of accuracy and industry. At the same time, he learns the obligation of practicing justice in the use of money and goods at home, in school, in the community.

The child in the *fifth grade* should have acquired a basic knowledge of the four fundamental processes, a rich background of experiences with number, and a meaningful vocabulary of arithmetical terms. He should have developed reasonable speed and ease in computation as well as the habit of accuracy in all operations. He should be able to use a textbook without confusion or loss of time, and to read and to

solve problems corresponding to the needs and abilities of children of this grade. The slower learner can be encouraged to progress at a rate which will insure understanding and mastery, even though of a limited number of facts.

By the time the child has reached the *sixth grade* he should have developed satisfactory habits of quantitative thinking. He recognizes the significance of number relationships and the need for skill in problems. He comes to a further understanding of fractions, decimals, and denominate numbers. He refines the four fundamental processes. He applies the knowledge of these operations, particularly, in reference to decimals, money, keeping accounts. The child increases his ability to make comparisons and precise judgments, and to develop habits of accuracy in measuring and problem solving.

In the *seventh grade* the child increases his skill in the fundamental operations and broadens his understanding of arithmetical concepts. His knowledge of measurement is extended to include properties of the circle, the volume of rectangular solids, etc. Emphasis is given to geometric constructions which are shown to be part of the design of nature from which man takes his pattern for building. In the study of percentage are found many practical problems related to daily living. The relation of Christian Social principles to economics is demonstrated in reference to family wages, cost of living, the payment of just debts, and the borrowing and lending of money.

In the *eighth grade* the child achieves mastery of all the fundamental operations according to his ability and extends concepts developed in preceding grades. Problems in measurement include the study of the cylinder and pyramid. The child learns about the use of taxation, mortgages, and insurance, stocks and bonds, real estate, cooperatives, and credit unions. He sees the application of geometric form to city planning, to machine construction and production. He becomes increasingly aware of the need for budgeting, wise marketing, and a living wage for all workers. As he grows in understanding of number values, he grows accordingly in the knowledge of the right use of numbers in his everyday living.

Now to summarize—Consistent application of basic principles will enable us to reach an arithmetical goal. Remember arithmetic is a system of thinking. Are we forward looking? Is our teaching interesting, stimulating, challenging? If we have lost some of our original zest and enthusiasm, let us make every possible effort to regain these qualities. Today all our activities and environment are permeated with quantitative relationships which we can understand and deal with adequately only, if we have a thorough mastery of arithmetic. Therefore, it is important that our pupils learn to look upon arithmetic as a socially useful subject which can be used to solve the prob-

lems that arise in their everyday experiences both in and out of school. The child who is successful as an individual, the child who feels security in his mastery of assignments, who is daily using his power to the fullest extent, and who is free from the frustration that failure occasions, is also the child who is ready to meet his social responsibilities with confidence, initiative, good will, and consideration for his fellows. Results will be achieved if the meaning theory is consistently followed.

THE 1949–50 PROGRAM OF THE MATHEMATICS TRENDS COMMITTEE*

Virginia Terhune, Proviso Twp. High School, Maywood, Illinois Kathryn Kennedy, Indiana State Teachers College, Terre Haute, Indiana. Donovan Johnson, University of Minnesota, Minneapolis, Minnesota. Phillip S. Jones, University of Michigan, Ann Arbor, Michigan. Vernon Price, Iowa University, Iowa City, Iowa.

The Mathematics Trends Committee was first appointed for the yea 1948–1949 with Dr. Phillip Jones as chairman. His report for the committee you heard last November at Indianapolis, or read later in the SCHOOL SCIENCE AND MATHEMATICS magazine.

The recommendation of the committee at that time was for its continuance with an enlarged membership, under a rotating chairmanship. The present committee was appointed in April. Mr. Herbert Edwards, our mathematics section chairman, instructed us to prepare for this meeting a brief outline of the program of work which the committee would attempt for the year 1949–1950. Mr. Edwards and the committee both recognized the impossibility of doing more than that in the time from April to November, interrupted by a three months' summer holiday.

Through correspondence we made a tentative list of objectives, which later was narrowed down considerably as correspondence continued, and again after we met and talked things over last night. We felt that there was a tremendous field open, but that for this year the committee should attack some single phase of trends in mathematics education.

We as individual teachers feel we need to know what new work is being done in mathematics education, in small projects being carried on by individual teachers, and in the broader projects of curriculum revision. To be more specific: we decided to function as a sort of clearing house—to find and report on what is being done in four particular areas:

1) What new courses are you offering in mathematics? For example, many of us are interested in a course for high school seniors. How are schools handling this problem? Should we offer seniors mathematics of the kind they will soon need when attempting to manage their own family budgets? What schools, if any, have set up a non-college preparatory course for seniors, and what does such a course contain?

2) Is there any widespread attempt to completely reorganize mathematics courses, where the traditional subject matter divisions are ignored? Dr. Reeve a year ago talked to this group about such a reorganization in discussing a General Mathematics program. Dr. Price at the same meeting described what is being done in Iowa in breaking down the usual barrier between Plane and Solid Geometry. Are other schools experimenting along these lines, and if so, with what success?

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* Committee report presented at the Chicago meeting, Nov. 1949.

3) What changes are taking place in the sequence or grade placement of the mathematics courses? In some schools General Mathematics for one semester is required of all ninth graders, this requirement thereby pushing the usual algebra course into the second semester of the ninth year. In others General Mathematics is required for all of the ninth year, but is so organized as to include the equivalent of one semester of algebra, the second semester coming at the tenth grade level. What other changes in placement are being tried?

4) Finally we are interested in new approaches to the traditional courses, and in the development of new units of work within these courses. Have any of you, for example, become enthusiastic about some one unit of work and carried it beyond the usual text book offerings? The Trends Committee is interested in such experimental work of teachers.

The committee is faced with the difficult problem of finding the people who are doing this experimenting. We are sure there are a great many of them, and that many have no intention of publicizing their work because they lack the time to do so or because they have the modest and erroneous notion that all other teachers are doing the same things. We want your help in a way that will be explained a bit later.

If in the next year we are successful in locating these teachers, the committee plans to present in its 1950 report a summary of their experiments. If sufficient data is unearthed, the committee feels that a cross reference file might be set up. Teacher X in school A, wanting suggestions and help in revising course B, might write to the Trends Committee. The committee in turn, consulting its file, could send to teacher X the names of teachers Y, Z, and W who have worked along similar lines and who would be willing to share their ideas with teacher X.

As I mentioned before, finding teachers Y, Z, and W is our real problem. In that you who are here can help most. The very fact that you gave up a holiday to attend this meeting testifies to your interest in solving our mutural problems. Many of you are no doubt doing some of this experimental work. Many of you know of teachers who are. Will you help us serve you and the Association by giving us the leads we need? Will you give us the name of any person, yourself or a colleague, whom you know to be doing something original or different along the lines described? We hope you will give us so many leads that we will be very busy in the next year and will have a very complete report of our findings in 1950.

EROSION BY RUNNING WATER

Julius Sumner Miller
Dillard University, New Orleans, La.

Soil and even rocks (although to a lesser degree) are eroded away by running water. In time erosion can level mountains! And the millions of streams both large and small work endlessly to "wear away the earth." To demonstrate on a small scale the processes of erosion by running water perform the following:

Pile up a conical-shaped mound of earth. This may be done outdoors most easily but it can also be done in the classroom if provision is made. Now slowly pour water from a beaker onto the top and walls of the mound of earth. The conditions of pouring as well as the make-up of the earth can be varied infinitely. The water can be dropped from great heights to hit the earth with great force, as in a thunderous downpour, and the soil can be varied by including sand and pebbles. The steepness of the slopes can be varied too. In all of these arrangements the variations in the "wash" can be noted. The small channels cut into the mound of earth by the running water may be likened to streams; the slope of the mound provides differences in stream gradient. The deposits at the base usually fan out and may be likened to the alluvial deposit. Huge alluvial fans have been built at the base of mountains and at the mouths of rivers.

CONSERVATION EDUCATION IN ELEMENTARY SCHOOLS*

ANNA E. BURGESS

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WHAT WE MEAN BY CONSERVATION EDUCATION

Most educators agree today that conservation is neither a subject nor a topic to be taught in isolation. Neither is it the responsibility of science teachers alone to develop concepts of conservation. Rather, the need for conserving and using wisely what they have, as well as replacing what has been used up, touches the lives of pupils day after day, year in and year out. Conservation education is the responsibility of every teacher.

Conservation is a widely inclusive term. We think immediately, of course, of conservation of soils, water, minerals, forests and wild life, but conservation means more than that. Are not habits of thrift, personal safety, and health also aspects of the same problem? Conservation enters into many of the traditional areas of subject matter but it will also be an integral part of units of work that cut across subject matter lines. We realize that much conservation teaching must be clear-cut and well-planned, but a great deal of effective teaching will be done by developing the principles and practices at the time and point of need. To the teacher who is conservation conscious, the entire curriculum is filled with opportunities for building life-long attitudes and habits in this field.

As teachers of conservation, therefore, we should keep in mind three fundamental goals for our pupils: appreciation of what they have, a sense of responsibility for saving and using wisely all resources and establishment of many specific conservation practices to the degree that they have become habitual. These goals can be attained only through knowledge based upon many experiences.

CONSERVATION TEACHING WITH FIVE- AND SIX-YEAR-OLDS

In the earlier days of our experimentation with conservation education at the elementary level, we placed some units in grades four, five, and six only. Soon the teachers of these grades began to suggest that the ideas of conservation should be started much earlier.

Now, we believe that we cannot begin conservation teaching at too early an age. In fact, as soon as a child in the home is old enough to pick up a toy from the floor and put it into a box, so it will not be broken, the mother can begin conservation education. The concept

* Presented to the Conservation Group of the Central Association of Science and Mathematics Teachers November 26, 1949.

that we must take care of our belongings is probably one of the earliest conservation principles to be learned.

In Cleveland, as in many other places, we center our kindergarten and primary curriculum units around increasingly larger areas of experience. These units may include content from many subject matter fields. In the kindergarten and lower primary years, the emphasis is largely on the school and the home; in the middle primary on the larger neighborhood, but still within easy reach of the school, while in the upper primary, the emphasis is extended to include the entire Cleveland community, both past and present. In relation to conservation, we also take a glimpse into the possible future.

In accordance with these themes, conservation concepts are developed from the very simple to the more complex. The five-year-old in kindergarten learns that he must not waste his paints, crayons, and paste. He learns that many times he can draw a picture on both sides of his paper. He learns, too, that putting the cover on the jar of showcard paint will save what is left for the next time. The skillful teacher may present this through a simple experiment: one paint jar is set away uncovered; the cover of the second jar is screwed tightly; on the next day the paint in the two jars is compared and the reason for covering the jars after using is stressed once more. The teacher brings out that paints cost money, that they have only a few jars of each color, that if they are wasteful they cannot paint pictures. Care of all materials becomes a part of habitual daily practice. Is not this conservation education?

When the children go out of doors for a walk, education in conservation of natural resources begins. Appreciations are awakened at this early level—appreciations through happy experiences and simple observations. The interesting plants and animals to which their attention is called are their friends; one takes care of one's friends. Consequently, one does not pick wild flowers nor break branches of shrubs nor hurt the birds. The mother of one little boy reported that her son reprimanded her for picking some flowers in the woods. He said, "Don't pick those flowers, Mother, or there won't be any left for my grandchildren."

Walks in the neighborhood will also provide the teacher with the opportunity to build up the habit of staying on the sidewalk to save the grass and of being careful of others' property. How the neighbors will appreciate such instruction! Ninety-nine per cent of children do not run across lawns and break shrubbery in a spirit of vandalism. They are merely thoughtless. No one has taken the time to discuss how and why such acts are harmful. They have merely said, "Don't."

Simple planting projects, indoors and out, help to develop respect for plant life. When children have planted seeds for their greenhouse

project, when they have had to wait a long time for them to sprout, and have watered and cared for them for many days, they will see the reason for protecting lawns, flower beds, and gardens out of doors.

Upper Primary Conservation Activities

By the time boys and girls are seven or eight years of age, they can understand quite well why some habits are good and others are harmful. They can begin to reason from cause to effect for themselves and to assume more responsibility for planning and directing their own activities. At this stage, teacher and pupils plan together many specific projects that will help to protect the plants and animals in their neighborhood. Through a more intensive study of some of the animals an attitude of friendliness develops which comes only through acquaintance and knowledge.

One teacher who was exploring experimentally with her second year class the conservation possibilities of a unit on the neighborhood, developed through specific activities an unusual amount of interest. These are some of the activities carried on throughout the year:

- Surveying the schoolyard to see where grass had been worn off by careless walkers
- Planting grass seed on bare spots
- Giving talks in other rooms
- Raking leaves at home and helping Father make a compost pile
- Finding trees where branches were broken and painting the scars with shellac
- Making bird feeding trays for home and school
- Having a sale to earn money for food for winter birds
- Joining a Junior Conservation Club (currently being promoted by the Cleveland *Plain Dealer*)
- Learning about animals and trees in the neighborhood
- Visiting a neighborhood greenhouse
- Painting a series of pictures to show what they had done

The teacher made charts to record individual pupil activities outside of school. This was a great encouragement to look for things to do.

In the study of Indian life, pioneer life in early Cleveland, and of life in Cleveland today, many conservation ideas are brought out. At this upper primary level, the concept is presented that trees and wild life may be wasted or may disappear to make way for towns and cities. With this thought is presented the two questions, "What can we do to prevent further loss?" and "What can we do to restore some living things to our Cleveland community?" At this point the conservation booklet by Mary Melrose and Paul Kambly, "Would You Like to Have Lived When—?" is very valuable. It affords supplementary reading for the unit on pioneer life, but in addition, it presents four important points of emphasis in conservation:

They (the pioneers) cut down too many trees.
They killed too many birds.
They killed too many other animals.
They plowed up too much land.

The teacher can take her class out to nearby parks, fields, or woods to test the truth of these statements. Here children learn that soil washes or blows away when it is left bare. They imagine what Cleveland was like when it was covered with forests. They find out that the city and county own many acres of parkland where plants and animals are protected by law. Then comes the important question, "What are we going to do about it?" One boy said that he thought that when they were grown up they ought to elect somebody who would clear away the dump on the lake front. The class will not have to wait so long as that, because the city officials are already at work on lakefront beautification, but we may be sure that those children will vote for conservation projects, whatever they may be.

Conservation in Grades Four to Six

The older children attack the problem of conservation from two angles: the local needs, and the national situation.

We are still handicapped by lack of enough reading material simply written, but it is surprising how much information the fifth and sixth grade child can glean from government pamphlets when the motivation is strong. To an increasing degree, science books are being written which give attention to conservation—not as a separate unit, usually, but as a part of other units.

Some of the aspects of the conservation problem covered in the three upper grades in Cleveland are listed at the end of this article. As many actual out-of-door experiences as possible are used to teach conservation of natural resources, but often these firsthand experiences are not practical at the moment. Many classroom experiments can be substituted for the actual situation. Take the development of an understanding of the meaning of soil erosion, for instance.

To teach erosion caused by running water, two slopes of soil can be built up in two pans or old aquariums. One slope is left bare, the other is covered with sod. Equal amounts of water are poured on each slope. It is easy for the class to see that soil is washed from the bare slope while the planted slope is able to absorb most of the water. "Make water walk, not run," then has real meaning. These slopes can also be used to experiment with terracing, strip-planting, and contouring in contrast to up-and-down-hill row-planting.

Many methods should be used to supplement the direct experience. Reading, discussion, making charts, preparing assembly programs, setting up exhibits, planning bulletin boards, viewing films, and tak-

ing as many trips as possible all help to deepen the impression of need for conservation.

PARK PROTECTION CLUBS

Perhaps one of the most effective ways of promoting interest in conservation on the local scene is through a club organization. Children of elementary school age like clubs, especially if they can have a major share in planning programs, and in conducting the meetings.

Since about 1936, the elementary schools in Cleveland have been conducting as an elementary science project, Park Protection Clubs in as many schools as wish to participate. These clubs are on a completely voluntary basis. The main purpose of the club is to educate the children in the school to take care of the parks and public properties in and around Cleveland. Practically, it has proven to be excellent training for effective citizenship. Park Protection Club members make for themselves a solemn pledge to do all they can to protect the natural treasures of their environment. In individual schools, programs consist of such numbers as original plays, bird and tree contests, films, and listening to reports or to an occasional outside speaker.

Once a month two representatives from each club convene at a central place, usually at the Museum of Natural History, for a meeting with the supervisor of elementary science. At these meetings they often listen to specialists in various phases of natural science. They exchange ideas with each other as club representatives report. Incidentally they are becoming more and more enthusiastic over their club work.

As an Arbor Day project each year the Park Protection Clubs have paid for trees to be planted in one of the parks. The Commissioner of Shade Trees for the city, Mr. Edward Scanlon, suggested that such plantings might become annual civic activities, so tree-planting ceremonies are planned by Mrs. Grace C. Maddux, Assistant Supervisor of Science. These take place simultaneously at many different locations in the city. For each ceremony one school plans the brief program, in which not only the children participate, but also a representative of the city government and a member of the staff of the superintendent of schools. Both public and parochial schools are interested in the project.

The future of our country rests in the hands of the children now in our schools. Since conservation is essentially a way of life needed to insure for years to come an ample supply of material resources, we must not delay nor neglect conservation education. To wait for this instruction until the child is of high school age is dangerous: habits and attitudes are formed in early childhood. Elementary teachers

must lay the foundations on which the high school and college can build more specific techniques of conservation practice.

CONSERVATION EDUCATION IN CLEVELAND ELEMENTARY SCHOOLS

Our Goals: Knowledge Appreciation Conservation

Kindergarten

1. Many experiences which will develop an interest in and an appreciation of the plants and animals in the neighborhood.
2. Simple conservation practices e.g., staying on sidewalks on the way to school, walking on the paths in the parks to protect grass and shrubs, putting out food for the birds in winter.
3. Learning to use materials without wasting them, e.g. paper, crayons, paints.

Primary Division

(First Year units centered about school and home experiences; second year units centered around the neighborhood; third year units branching out to include the entire city.)

As outcomes of experiences, discussions, and definite activities connected with primary units, the following phases of conservation are developed:

1. Protection of yards, parks, lawns, shrubs, trees, gardens, and wild life near the school, at home, and in our city parks.
2. Responsibility for helping to keep schoolroom, schoolyard, and streets clean and attractive.
3. Care of school supplies and books.
4. Care of clothing to make it last.
5. Keeping safe and healthy.
6. Feeding birds in winter.
7. Learning to recognize a few animal friends.
8. Comparison of Cleveland today with Cleveland in pioneer days; reasons for disappearance of trees and wild life; methods of saving and replacing some of them.
9. Gardens: "the beginners' garden."
10. The Junior Conservation Club.

Upper Elementary Division (Grades 4–6)

(Many of the following topics are parts of more comprehensive units.)

1. Conservation of wild flowers.
2. Conservation of birds.
3. Conservation of trees.
4. Inter-relationships between plants and animals. Learning to protect the helpful and control the harmful plants and animals.
5. Control of harmful insects.
6. Control of rats.
7. Conservation of natural resources, locally and in state and nation

soil	forests
water	wild life
minerals	fish
fuels	

8. Prevention of fires.
9. Prevention of accidents (taught at point of need)
10. Conservation of electricity.
11. Conservation of eyesight.
12. Park Protection Clubs.
13. Community tree-planting projects.
14. Home gardens—School gardens.

MATHEMATICAL ANALYSIS IN ELEMENTARY PHYSICS

BROTHER ALBERTUS SMITH
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The following problem is recommended for the consideration of the better students in high school physics. Its pedagogical value lies in the fact that it was originally brought to the attention of the writer when it arose as an interesting challenge to two students at the conclusion of a laboratory period devoted to the study of the inclined plane. The problem concerns a proof or an analysis in terms of mathematics of the self-evident fact that the efficiency of the inclined plane increases with the increase in the angle of inclination. More specifically it concerns the expression of the efficiency of the inclined plane in terms of a function of its angle of inclination.

The writer feels that even though the derivation is not of interest for its own value, it does illustrate to the student the method of mathematical analysis (a topic much too often neglected because it is falsely considered of no interest to elementary students), it does lie within the grasp of students pursuing a course in plane trigonometry, and it often can be brought to the attention of the students under circumstances which the writer will outline below.

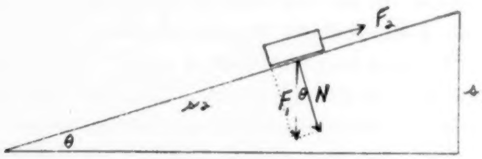
Two conscientious seniors, students of physics, still remained in the laboratory putting the finishing touches on their calculations for their data sheets on the experiment concerning the inclined plane. As the teacher glanced through the data sheets which had already been turned in, he noticed that in several instances on scattered pages a decrease in efficiency of the inclined plane was reported for an increase in the angle of inclination. He asked the two remaining students whether or not there should be an increase or decrease in efficiency under the aforementioned conditions. It happened that one of them was also including (for one trial) such a conclusion. Immediately they both agreed that such a result was absurd because they said it was apparent that the efficiency of the machine must increase if the angle of inclination was increased because the component of force due to friction which acts normally to the inclined plane approaches zero as the angle of inclination, θ, approaches 90°. They realized that barring faulty arithmetic the result could only be due to poor experimental technique or observation. The teacher then posed the question, "How could we show this to be true in terms of mathematics?"

The writer and students spent a half-hour or more working on the problem. Since the approach to the problem was new to the students

the solution to it could not be considered theirs, but they did absorb the method and understood it perfectly. The suggestion that they record the problem and its solution in their notebooks with the possibility that they be called upon to explain it to the class at some future date, was taken very enthusiastically and it is recorded here as it was outlined that afternoon.

Problem: Does the Efficiency of an inclined plane increase or decrease with the increase in the angle of inclination?

Solution:



$$F_2 = F_1 \sin\theta + \mu N$$

$$\text{Efficiency} = \frac{F_1 s_1}{F_2 s_2} = \frac{\text{output}}{\text{input}} = \frac{F_1}{s_2} \cdot \frac{s_1}{F_2}\,.$$

Since for a given weight and given incline F_1 and s_2 are constants, *i.e.* $F_1/s_2 = k$, then

$$\text{Efficiency} = \frac{k s_1}{F_2}\,.$$

From the figure the following facts will be evident:

(1) $\sin\theta = s_1/s_2$ or $s_1 = s_2 \sin\theta$

(2) $\cos\theta = N/F_1$ or $N = F_1 \cos\theta$.

Using these facts the following substitutions may be made in the expression representing the *actual* force which must be applied to produce motion along the inclined plane:

$F_2 = F_1 \sin 6 + \mu N$ (μ is the coefficient of friction and will be

$F_2 = F_1 \sin\theta + \mu F_1 \cos\theta$ constant for a given object.)

$F_2 = F_1(\sin\theta + \mu\cos\theta)$.

Then making further substitutions into the expression for the efficiency of the inclined plane, the following is true:
Therefore,

$$\text{Efficiency} = \frac{k \cdot s_2 \sin\theta}{F_1(\sin\theta + \mu\cos\theta)} = \frac{k \sin\theta}{k(\sin\theta + \mu\cos\theta)}$$

$$\text{Efficiency} = \frac{\sin\theta}{\sin\theta + \mu\cos\theta} = \frac{1}{\dfrac{\sin\theta + \mu\cos\theta}{\sin\theta}}$$

$$\text{Efficiency} = \frac{1}{1+\mu\cot\theta}\,.$$

From elementary trigonometry it becomes clear that as θ increases $1+\mu\cot\theta$ decreases, and therefore the efficiency must increase.

A Second Conclusion:

When the angle of inclination is that angle whose tangent defines μ, the coefficient of friction, the efficiency must be 50%.

For,

$$\underset{(\mu=\tan\theta)}{\text{Efficiency}} = \frac{1}{1+\mu\cot\theta} = \frac{1}{1+\tan\theta\cot\theta}$$

$$= \frac{1}{1+1} = \frac{1}{2}$$

$$= 50\%.$$

As a final comment the writer wishes to emphasize that he is not trying to plug this type of problem as requirement for all students, but he does feel that if occasionally the best students can be given an opportunity to present such examples of analysis to their fellow students, all will benefit greatly by them. It is the aim of general education to teach mathematics for appreciation, to indicate the relationship between fact and the expression of it in terms of the symbolic language of mathematics. It is not important that every student be able to reproduce all information, but it is important that he grasp fundamental concepts of the relationship between science and mathematics. Furthermore such problems furnish our best students with a better bridge over the gap between elementary and advanced mathematics.

Rotating brush, an improved type to attach to the end of the hose when washing cars or windows, adds a cleaning material to the water when desired or delivers untreated rinsing water. Operator flips a switch to add the detergent. A water-operated turbine in the device gives the rotating action.

Portable addresser, easily held in use by fingers and thumb of one hand, is designed to get mail addressed quickly and accurately by organizations with limited mailing lists. Master copy is typed on a spirit roll which holds 250 addresses and is easily inserted into the machine.

A PLEA FOR THE THIRD DECIMAL PLACE

V. A. Bolen
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Of late years I am becoming more and more disturbed at the shallow and careless thinking habits of my students. In keeping with the spirit of supersonic speed, they seem to be in a great hurry to arrive at almost any kind of an answer to a problem and be off on some other quest.

Recently one of my students in working a chemistry problem found an answer to be six hundred thousand. Shrugging his shoulders impatiently at such an odd number, he retorted, "Well, let's just round it off at three-quarters of a million." Obviously such is the language like that of a loose-thinking politician and not a scientist. Of course such exhibitions of careless thinking are disturbing to the teacher of science, but on the other hand they may also be a challenge.

Each fall as I survey my beginning chemistry class, I realize that probably not more than four or five per cent of the students will ever become real scientists. However, all of then will become home-makers, law-makers, business men, and citizens in all sorts of important and responsible positions. Certainly within the next ten or twenty years it will make little difference if they cannot quote Boyle's Law verbatim, demonstrate Avogadro's Number, or derive the mathematical expression for the Law of Chemical Equilibrium. It will make a great difference, however, whether they can think straight and apply the principles of the scientific method to their daily problems, decisions which may not only affect them as individuals, but may well affect the whole world for weal or woe.

Recognizing the need for an understanding and appreciation of the scientific method, it occurs to me that we science teachers are especially favored with abundant opportunities to teach straight and honest thinking. Our subjects call for the most precise, the most sustained, and the most closely-knit set of good thinking habits. In contrast with many other subjects, ours are most exact and exacting. They lend themselves naturally to the application of the principles of the scientific method which, when understood, may be used in any problem situation.

That our students are weak in their ability to do real thinking or to even approach the fundamentals of the scientific method is evidenced by the fact that when asked to use it, they often complain that they have never heard of such a thing. The call to teach clear, concise, and straight thinking is not new. However, our success in answering the call may be questioned. Superstition is still rampant.

What happened at Dayton, Tennessee is easily recalled. Giant skyscrapers are still built without the thirteenth floor. Second-rate politicians still ride into important offices on a wave of half-baked promises, mistruths, and impossible propaganda. These things in themselves present a real problem to every teacher, and science teachers are especially challenged to do something about it.

Most educators fully agree that one of the main functions of formal education is to aid and encourage the development of the skills and capacities of the individual for successful participation in life activities and responsibilities. It follows then, that the most important thing we science teachers can do for our students is to help them acquire a chain of thinking and acting habits which square with the generally accepted procedures of the scientific method. Certainly it is obvious that the more slipshod the habits a subject or teacher permits, the more harmful they become in retarding or hindering the growth and development of those traits of clear and honest thinking. Much of this body of materials is filled with human interest which when properly presented will catch the enthusiasm and appreciation of even the poorest student.

Consider for a moment the trait of accuracy, without which mathematics and the physical sciences would only be a hodgepodge of meaningless theories. The development of the Periodic Chart of the Atoms from the early days of Mendeleyev down through Moseley to our present day is a classical example of how accuracy in measurement and thinking has paid great dividends in results, and how the investigators were not in a hurry to drop the "third" decimal place and round off annoying fractions. Mendeleyev, who did pioneer work on the periodic arrangement of the atoms, once said in effect, "Some day you will find element X which will be quite like the description I have predicted for it. The results of the study of my law and theory tell me so." We know that element X was discovered and found to be remarkably like the description predicted for it.

Later, taking his cue from Meldeleyev, Moseley, by further accurate measurements and deductions, was able to correct the flaws in the older theory and gave us our present periodic chart, which is a marvel to all who study it. These cases illustrate how great discoveries were made because scientists refused to slough off the "third" decimal place and take the path of least resistance in thinking.

A further telling example of the fruits of accuracy in science is illustrated by the investigation of the density of nitrogen by Lord Rayleigh. He found that nitrogen prepared from the air differed in density from nitrogen prepared by heating ammonium nitrite by less than one-half of one percent. It is obvious that many people would disregard such a slight difference. But not the scientists. From this

tiny difference came the discovery of argon as a part of the atmosphere.

Dozens of other examples of the importance of accurate measurement and thinking may be cited in the various fields of science. Certainly it is obvious that science teachers have available an abundance of material to use in motivating the student in the development of at least an appreciation for and the importance of accuracy.

Not only is accuracy a desirable trait in itself, but consider that of honesty. No prejudice or personal feeling is allowed to enter into the work of the true scientists. He must be absolutely honest. The temptation to falsify results or to use the results of others as one's own, is strongly resisted. It is not difficult to teach with strong emphasis that a lie or untruth can never be scientific. Every fact must be accepted as it stands without bias or preconceived notions which may unconsciously cause the accumulation of certain facts and the disregarding or overlooking of other facts.

No doubt there are scientists who would give their right arm to be able to announce a cure for cancer. But unless such a cure were a scientific fact and the proof could be demonstrated and reproduced, such an announcement would be the height of stupidity. From the facts known about atomic energy, scientists know that there is enough potential energy in a cup of water to drive a giant ship across the Atlantic and back. To announce that such energy had been released would be folly unless the investigator could prove his point. It is not difficult to find an abundance of evidence supporting the fact that if absolute honesty did not prevail in scientific research, what we call with pride our scientific laws and theories would be no more dependable than an exhibition of hocus pocus. It goes without saying that the science teachers are in an enviable position to emphasize the importance of honesty, not only in scientific work, but in any process of thinking through to the solution of any important problem.

Not only does the science teacher have many opportunities to aid in the development of such desirable traits as accuracy and honesty, but the habit of perseverance, or the ability to stick to a job and see it through to a finish, is profusely illustrated in our science literature One might mention Dr. Ehrlich's search for the "magic" bullets and the 605 experiments that failed. It was the 606th one that proved successful. When Edison had tried 750 different substances for filaments in his electric lamps and all had failed, some thought that he might be discouraged. He merely stated that now 750 things were known which would not work. One can never forget the Curies in their indefatigable search for radium and the subsequent success after months and years of toil.

So in any field of science to which we turn we find an abundance of opportunities for the teaching of appreciation for the traits necessary for good thinking. Could any one find more worthy aims than the development of the traits of accuracy, honesty, and perseverance and many others akin to them? Certainly such traits and habits are the very heart of the scientific method of thinking at its best.

A plea has been made for the "third" decimal place, but it is not a plea for the old transfer of training position, or a plea for any one to make a fetish of these important principles. If we science teachers are to see results of our teaching in the form of clear and straight thinking we must come down from our ivory towers of pure science and help develop a chain of good habits that will operate not only in the science classroom, but also in the home, on the farm, at the office, and in all problem situations. Take your cue, science teachers! Watch that "third" decimal place!

CEBCO FILMGUIDES

All films to which Cebco Filmguides refer are 16-mm. sound films produced either by Encyclopaedia Britannica Films or by Coronet Films, two of the leading producers in this field. The films may be rented or purchased from your local distributor or film library, or directly from the producer.

Supplied free with

DISCOVERY PROBLEMS IN GENERAL SCIENCE

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AEC PLANS NEW TOOL, WORLD'S MOST POWERFUL ELECTRON ACCELERATOR

Atomic scientists at the California Institute of Technology will get a new tool for nuclear physics study under plans announced by the Atomic Energy Commission.

It will be the world's strongest electron accelerator, capable of delivering billion-volt electron streams and X-rays, AEC said.

The machine will be rebuilt from a quarter-scale pilot model which scientists at Berkeley's Radiation Laboratory of the University of California used to check plans for a new seven-billion-volt "bevatron" now under construction.

The bevatron when completed will speed proton bullets with 6,000,000,000 electron volts. Protons, positively charged, are the building blocks out of which all atomic nuclei are constructed. The quarter-scale model is being rebuilt to speed electrons to velocities only one-millionth of one per cent less than the speed of light. The speed of light is the theoretical but unattainable top velocity for any material particle. Electrons are units of negative electricity.

THE RELATIONSHIP BETWEEN TEACHER LOAD AND STUDENT ACHIEVEMENT

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School administrators and teachers have suspected that student achievement in school subjects is greater when the teacher's load is light. Therefore, school authorities have advocated smaller classes and smaller loads in terms of the number of classes per day per teacher. Are school authorities justified in making this recommendation?

A possible approach to this problem is to test out experimentally the relationship between the number of pupils handled per day per teacher and the achievement of students in a specific class or classes. Thus a teacher having four classes per day, twenty pupils in each class would have 4×20 or 80 pupil contacts per day. Is this teacher load a factor in student achievement?

The following data were available: student scores on the final examination and the teacher load in terms of the number of pupil contacts per day. The data on teacher load were assembled from two studies involving: (A) fifty-six representative Minnesota high schools, and (B) seventeen schools in eight different states. The tabulation of these data is given in Table I.

TABLE I. NUMBER OF PUPILS HANDLED PER DAY PER TEACHER

	Q_1	Md	Q_3
Source A	76.4	100.8	128.7
Source B	86.5	94.0	147.5

SOURCE A

By means of random selection, representative classes were obtained from the fifty-six Minnesota high schools in which the number of pupils handled per day per teacher fell in the upper one-fourth of the distribution, and in which the number of pupils handled per day per teacher fell in the lower one-fourth of the distribution. The chemistry examinations used in Source A and in Source B, although different in content, went beyond the usual informational examinations in that they tested the following areas: acquisition of factual information, understanding of chemical principles, understanding and application of the elements of the scientific method together with the associated attitudes, and skills such as equation writing and solving weight-volume problems. By using the analysis of variance and covariance technique it was possible to hold constant the factors of pupil intelli-

gence and pre-test knowledge. The results are shown in Table II. The results of this statistical analysis showed that there is some evidence

TABLE II. CHEMISTRY CLASSES, ANALYSIS OF VARIANCE COVARIANCE, INTELLIGENCE TEST SCORES AND PRE-TEST SCORES HELD CONSTANT; AND ADJUSTED MEANS FOR THE TWO GROUPS COMPARED

Source of Variation	df	SS	MS	F	Adjusted Means	
Within Groups	80	4335.975	54.199		Upper ¼	33.91
Between Groups	1	288.054	288.054	5.31*	Lower ¼	40.42
Total	81	4624.029				

* Significant at the 5 per cent level.

that on the average, students achieved significantly more on the final examination in chemistry, holding pupil intelligence and pre-test knowledge constant, when the number of pupils handled per day per teacher placed her in the lower one-fourth of the distribution rather than in the upper one-fourth.

SOURCE B

In this analysis involving the seventeen schools in eight states, it was statistically possible to compare only the class just above the median mean value for the four classes in the upper one-fourth of the distribution, with only two of the four classes in the lower one-fourth of the distribution. Only the intelligence test quotients were held constant in this comparison. The results of this analysis are shown in Table III. The results of this statistical analysis showed that there is some evidence that on the average, students achieved significantly

TABLE III. CHEMISTRY CLASSES, ANALYSIS OF VARIANCE COVARIANCE, INTELLIGENCE TEST QUOTIENTS HELD CONSTANT; AND ADJUSTED MEANS FOR THE TWO GROUPS COMPARED

Source of Variation	df	SS	MS	F	Adjusted Means	
Within Groups	115	10062.002	87.495		Upper ¼	52.13
Between Groups	1	1966.209	1966.209	22.47*	Lower ¼	61.85
Total	116	12028.211				

* Significant at the 1 per cent level.

more on the final examination in chemistry, holding pupil intelligence constant, when the number of pupils handled per day by the teacher placed her in the lower one-fourth of the distribution rather than in the upper one-fourth of the distribution.

SUMMARY

Are school authorities justified in advocating lighter pupil loads

for teachers in order to secure greater pupil achievement? As far as this investigation is concerned the answer is yes within the limitations imposed on the findings. The evidence as presented in this study applies specifically to chemistry classes and not to other classes in the high school, although it is possible that same conclusion might obtain for other classes in other fields of knowledge. This ought to be verified by experimental evidence before all inclusive recommendations are made regarding teacher load. The small contribution made by this study and others like it should help to illuminate the many aspects of instruction.

ALCOHOL-POWERED CARS COULD SOLVE CROP SURPLUS HEADACHE

One of chemistry's great dreams—the day all automobiles will be powered partly by alcohol—was described here as a solution for the country's periodic headache, crop surpluses.

Dr. Philip J. Schaible, director of a Cincinnati research council, which seeks new uses for wastes from the nation's distilleries, told the National Farm Chemurgic Council the dream will some day become a reality.

Scientists have long known: 1. alcohol can be made not only from crops such as grain and potatoes but from crop wastes and wood wastes; and 2. alcohol-water-injection in gasoline engines can boost their power and save gasoline.

Edward W. Russell, former managing editor of the London *Morning Post*, told the convention that countries such as England that must import oil "sooner or later will find alcohol-water-injection essential."

Dr. Schaible predicted that grain alcohol for use as motor fuel would end grain surpluses in the U. S.

"But practical application to our economy is still something for the future," he said.

MAGNITUDE OF THE NATION'S EDUCATIONAL TASK

Federal Security Administrator Oscar R. Ewing called attention to the fact that year next there will be approximately one million more children enrolled in our elementary schools than are enrolled this year. And in the year 1952–53, there will be an unprecedented annual increase of over a million and a half in the number of elementary school pupils.

The March issue of *School Life*, official journal of the Office of Education, Federal Security Agency, predicts that "by 1959–60 there will be 10,500,000 more children enrolled in elementary and high school throughout the United States than in 1946–47." This increase alone represents a greater number of pupils than were enrolled in California, Illinois, Michigan, New York, North Carolina, Pennsylvania, Ohio, and Texas in 1946–47.

This means that if each teacher takes care of 30 pupils, the Nation will need about 350,000 additional teachers by 1959–60. The 350,000 figure does not include replacements for teachers withdrawing from the school systems because of age, marriage, or illness, or for other reasons. Moreover, this estimate does not provide for the supervisory personnel or specialized teachers who will also be needed.

MONSTER FORMATION INDUCED BY ZINC SULPHATE IN *PARAMECIUM CAUDATUM*

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Since the discovery by Müller in 1927 that mutation can be induced artificially by X-ray irradiation, various substances such as iodine, ammonia, mustard gas, metal compounds, and carcinogens have been tested in order to produce new forms.[1] Zinc sulphate, commonly known as white vitriol, is toxic to microorganisms, and therefore it is used in medicine as an antiseptic. Monsters of *Paramecium caudatum* were induced experimentally by cutting[2] and by exposure of dividing individuals either to low temperature or to cyanide vapor.[3] Mottram also discovered that *Paramecium* produced monsters in experimental cultures.[4] He added a small amount of 3:4-benzypyrene to the culture medium, causing some of the organisms to change into abnormal forms.

This paper presents the results of an investigation on the effect of $ZnSO_4$ on *Paramecium* with special reference to the induction of abnormal forms and monsters.

MATERIAL AND METHODS

The strains of *Paramecium caudatum* used in the experiment were obtained both from Peiping and Tientsin. Two sets of cultures were maintained: one set containing 1 cc. of 1% $ZnSO_4$ aqueous solution in 50 cc. of hay-wheat infusion, and the other 1 cc. of 1% $ZnSO_4$ in 100 cc. of the same culture medium. The culture medium was made by boiling 25 grams of rice stalks and 25 grains of wheat in 500 to 1000 cc. of tap water. Three days later the solution of $ZnSO_4$ was added. Paramecia were immediately inoculated as a mass culture in small petri-dishes or beakers which were covered with glass plates to prevent the excessive evaporation of water. Controls were kept for comparison. Daily examinations were made under a binocular microscope.

The room temperature of the laboratory ranged from 2 degrees C. to 21 degrees C., averaging 10 degrees C. in the winter and 16 degrees C. in the spring.

For the purpose of studying growth and reproduction, the induced

* Mr. Tien-hou Ho has not been heard from since the Reds took possession of China.

[1] Auerbach, C., J. M. Robson, and J. G. Carr, "The Chemical Production of Mutations." *Science*, Vol. 101, No. 2723, 1947, pp. 243–247.

[2] Calkins, G. N., *The Biology of the Protozoa*. Philadelphia: Lea & Febiger, 1933, pp. 215–217.

[3] DeGaris, C. F., "A Genetic Study of *P. caudatum* in Pure Line Through an Interval of Experimentally Induced Monster Formation." *Journal of Experimental Zoology*, Vol. 49, No. 10, 1927, pp. 133–147.

[4] Mottram, J. C., "3:4-Benzypyrene, *Paramecium* and the Production of Tumors." *Nature* (London), No. 145, 1940, 184–185.

abnormal individuals were isolated one by one and transferred to a depression slide. The depression slides were kept in moist chambers. Outline drawings of the living individuals showing various changes were made under a low power compound microscope. The size and proportion of parts were based on measurements with an ocular micrometer. The culture medium was changed every two days.

Observations

Paramecia grow well and reproduce rapidly in both sets of solutions previously referred to. Abnormal forms, such as truncated forms,

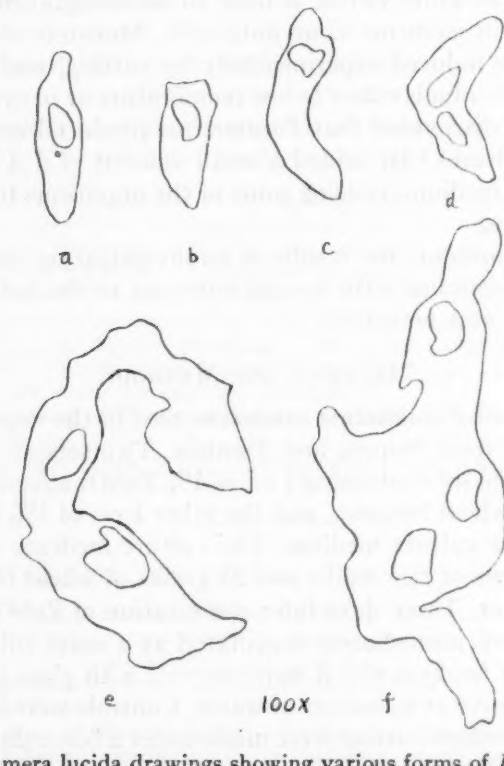

FIG. 1. Camera lucida drawings showing various forms of *P. caudatum* induced experimentally. Stained with methyl green.

a. Normal form for comparison.
b. Truncated form.
c. Abnormal tandem monster.
d. Tandem monster.
e. Chain of several connected individuals.
f. Amorphous mass.

abnormal tandem monsters, tandem monsters, and rarely some other types of monsters, are usually found in about 15 days in the winter and 8 days in the spring (Fig. 1: b, c, d). These organisms can not

only swim about, feed, and respond to various stimuli in a normal manner but also divide. The highest percentage of the abnormal forms thus induced is approximately 10 percent. The abnormal forms will not become normal again, even when they are placed in a culture fluid without $ZnSO_4$. The subsequent changes of the abnormal forms were carefully studied and described as follows:

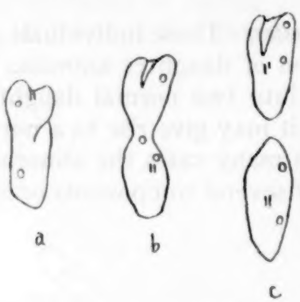

FIG. 2. Outline drawings of living specimen showing the successive stages in the change of the truncated form.
a. First day.
b. Third day.
c. Third day, one hour later than *b*.

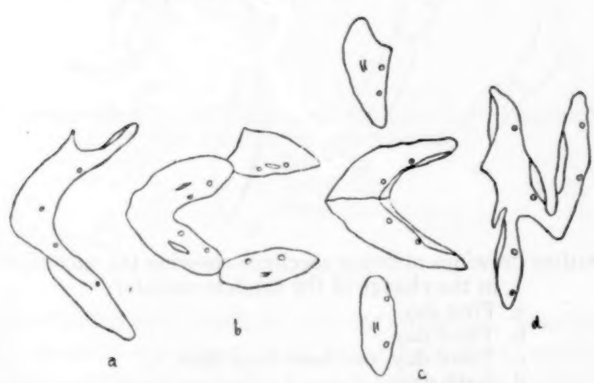

FIG. 3. Outline drawings of living specimen showing the successive stages in the change of the abnormal tandem monster.
a. First day.
b. Third day.
c. Third day, two hours later than *b*.
d. Fifth day.

(1) *The truncated forms:* The truncated forms usually show an abnormality in the anterior region of the cell, and only rarely in the posterior region. If isolated and cultured in fresh $ZnSO_4$ hay-wheat infusion, they will grow and reproduce. Two daughter cells result from such a division: one is normal both in size and shape, and the other is smaller and remains truncated in form (Fig. 2).

(2) *The abnormal tandem monsters:* These are chains of two daughter animals which failed to separate. One of the two components is truncated in form. They may exhibit the usual swimming movement, or swim with a clockwise-cyclic one. When isolated and placed in a fresh $ZnSO_4$ hay-wheat infusion, such a tandem monster will produce two daughter cells, one of which is truncated while the other is normal (Fig. 3).

(3) *The tandem monsters:* These individuals seem to be formed by delay in the separation of daughter animals. The tandem monster may become divided into two normal daughters on the second or third day (Fig. 4), or it may give rise to a normal and an abnormal individual (Fig. 5). In many cases the abnormal daughter cell may develop into a chain of several components or into a large amorphous mass.

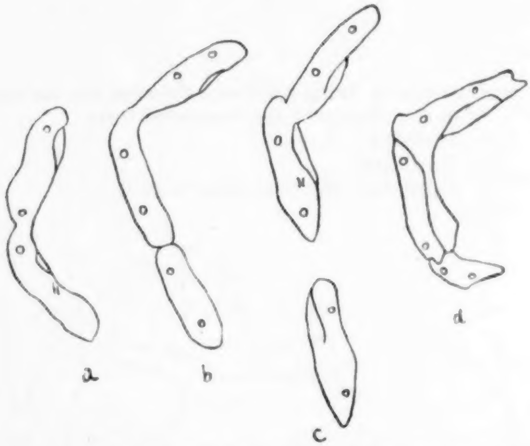

FIG. 4. Outline drawings of living specimen showing the successive stages in the change of the tandem monster.
a. First day.
b. Third day.
c. Third day, one hour later than *b*.
d. Sixth day.

DISCUSSION

Calkins[5] stated that the result of physiological weakness in *Paramecium caudatum* is a tendency to divide abnormally, leading to monster formation but that such individuals never grow into a large amorphous mass of protoplasm. The paramecia used in the present experiments belonged to cultures of conjugants, and large amorphous masses of protoplasm from mutilated individuals were obtained in many cases. Therefore, it can be concluded that the induced abnormal forms are not due to physiological weakness in an old culture but due to the particular effect of $ZnSO_4$ on *Paramecium*.

[5] *Loc. cit.*

All of these amorphous masses may live nearly one month. If suitable cultural conditions are given, it is possible they can live even longer. Frequently these monsters contain only one macronucleus. If there is more than one macronucleus, the number is usually less than the number of "individuals" composing the mass.

Other chemicals such as $(NH_4)_2SO_4$, $CuSO_4$, $MgSO_4$, $ZnCl_2$, and thiourea were tested. All failed to induce abnormality. These tests show that the effect of $ZnSO_4$ does not seem to be due to Zn^{++} or SO_4^{--} alone, but due to both.

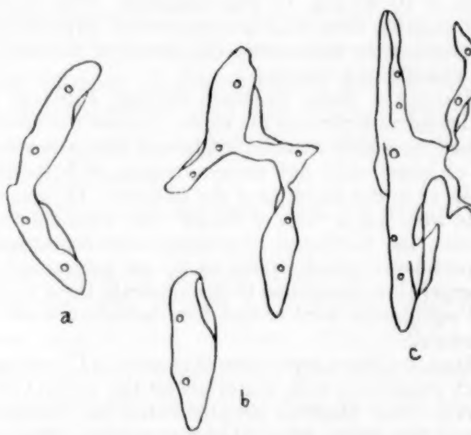

FIG. 5. Outline drawings of living specimen showing the successive stages in another tandem monster.
a. First day.
b. Third day.
c. Fifth day.

SUMMARY

(1) Abnormal forms, such as truncated forms, abnormal tandem monsters, tandem monsters, and other monsters, were induced in *Paramecium caudatum* by adding small amounts of $ZnSO_4$ to the hay-wheat infusion. Such forms appear after about 15 days in winter and 8 days in spring. They can swim, feed on bacteria, respond to various stimuli, and reproduce.

(2) The abnormal specimens were isolated and transferred back to normal culture medium in isolated cultures. It is worth noting that they cannot recover normal form.

(3) The changes in these abnormal individuals were studied. They can transform by incomplete division into triples, chains of several connected individuals, or into large amorphous masses. All of the masses can live nearly one month.

(4) Related chemicals such as $(NH_4)_2SO_4$, $CuSO_4$, $MgSO_4$, $ZnCl_2$,

and thiourea were tested. All failed to induce abnormality.

(5) The effect of $ZnSO_4$ on *Paramecium* seems to be neither from Zn^{++} alone nor from SO_4^{--} alone, but from both.

REPORT OF THE CASMT NOVEMBER MEETING

Elementary Science Section

The annual meeting of the Elementary Science Section of the Central Association of Science and Mathematics Teachers was called to order on Friday, November 25, 1949 at 10:40 A.M. by the chairman, Miss Viola Neuman. The minutes of the last meeting were read and approved. Miss Neuman announced the names of the nominating committee composed of Edna Bryne, chairman, Marylou Ebersole and Martha Curtis.

Dr. Dwight Sollberger of State Teachers College, Indiana, Pa., opened the program with a brief introduction to his topic, *Science Activities for Children in the Elementary School*, at which time he explained that a teacher, performing a demonstration for children, may not always be sure of outcomes; either in the demonstration itself, or in the learning of the observer. He also emphasized that science experiments were not a "bag of tricks" but were demonstrable answers to childrens questions. Dr. Sollberger distributed mimeographed materials containing simple experiments which could easily be performed by teacher and children. Dr. Sollberger then proceeded to demonstrate these simple experiments. The materials and equipment used in the demonstration were simple, inexpensive, and accessible to all.

Mrs. Grace Maddux, assistant supervisor of science in Cleveland, continued the program with a rich presentation of materials on the subject of *Techniques and Values of Field Trips*. Mrs. Maddux supplemented her discussion with motion pictures and colored film-strip. Mrs. Maddux ascribed the more meaningful experiences of children to out-of-door trips. The color slides were beautiful and clearly demonstrated the effectiveness of field trips on the elementary level.

Miss Neuman brought the program to a close after a brief discussion on the materials presented by the speakers.

The chairman of the nominating committee presented the names of the following persons who were unanimously elected for the coming year:

Chairman: Miss Viola Henrikson
Girls Latin School
Chicago, Illinois

Vice Chairman: Mr. Albert Piltz
Roosevelt School
Detroit, Michigan

Secretary: Miss Ella Nichols
City Schools
Alma, Michigan

Albert Piltz, *Secretary*

The best luck in the world is to learn to depend upon yourself. The man who leans upon other people is easily upset, but the man who has learned to balance himself on his own feet is independent of all men. You hold within yourself the promise of all you will ever be. To whatever extent you depend upon other people you are not your own—you have borrowed yourself from them. Be yourself.—Roy L. Smith in *The Christian Advocate*.

GENERAL MATHEMATICS AT THE COLLEGE LEVEL

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This paper is based in part on one of the scheduled discussion groups at the Tenth Christmas meeting of the National Council of Teachers of Mathematics at Wichita, Kansas, December 30, 1949. The discussion was brief and no general agreement was reached but a number of questions concerning this perplexing problem were raised.

The expression "General Mathematics for College Students" is often confusing because of the different interpretations put on the term "general mathematics" and the different types of students for which the course may be intended. Hence for clarification the following statements will be made:

1. General mathematics courses may be offered to two distinct groups of college students.

1). The non-scientific or general students.

2). The students who expect to continue the study of mathematics, science, engineering or some other field which requires a rigorous, sequential knowledge of mathematics through the calculus.

2. General mathematics is so-named because it includes some integration between the various branches of the subject and some emphasis on the general concepts of the subject.

These statements will eliminate some of the confusion connected with this topic but by no means all of it.

Mathematics for the Non-Scientific or General Student is becoming increasingly important in college education. A large number of schools give such a course or courses which are often required of a large percentage of the students enrolled in a particular college or division. The content and organization of the mathematics for these students is best characterized at present by its variability. Some of the problems encountered by the people offering these courses are: the preparation, or lack of preparation, of the students, the transfer of credit to other institutions, the needs of the students, the type of subject matter to meet these needs, the scarcity of adequate textbooks, whether students should learn mathematics or *about* mathematics, etc.

A fundamental difficulty is that the term "general education" has no generally accepted definition. It may be characterized indirectly in the following statement: "General education as a movement has attempted to correct the undue emphasis on specialization, on the acquisition of factual information and technical skills and the almost exclusive emphasis on the intellectual development of the student

which has come to be associated with the more traditional educational programs.—This movement—is designed to encourage the integration and retention of the knowledge and skills gained by the students and to provide opportunity for emphasis on long-term goals of instruction."

If we think of mathematics in terms of the above statement, a method of evaluation becomes one of the primary problems involved. This would enable us to compare one program with another, since there exists no absolute standard by which we can determine that a given program is best. In other words, we may ask the question: Does this course in general mathematics result in *more* growth toward a particular objective or set of objectives than some alternative course? To answer such a question we must

1. have a clear understanding of the objectives and their meaning in terms of student behavior
2. develop devices or techniques of collecting evidence on such student behavior
3. collect such evidence at two or more stages of development so that results may be interpreted in terms of changes in the student
4. compare the gains of similar groups of students exposed to different types of educational experience or courses.

While such a procedure involves some agreement on objectives, it does not involve an absolute agreement on all objectives. We would probably find enough agreement for a beginning. The big problem is in developing satisfactory means of collecting evidence of growth or change in the students.

Moreover, the major purpose of any such evaluation study is improvement. The problems of teaching mathematics to this type of students are real enough. We may anticipate that more than one solution to them exists and hence that the purpose of such a study is to determine wherein we have made most progress and what channels should be explored farther, rather than to find the best program. Hence the lack of evaluation techniques, the present tentative nature of most courses in general mathematics for these students and the probable lack of any unique solution to the problem of the content and organization of the subject matter seem to indicate that we should concentrate on the improvement of evaluation *in* the course rather than an evaluation *of* the courses already organized.

Mathematics for Future Specialists is fairly well standardized as to the content needed during the first two college years. In this paper we shall be interested in the organization of this subject matter and in particular those types of organization to which the term "general mathematics" may be applied. This content of two years of college

mathematics, or through the calculus, may be organized for teaching and learning in several ways:

1. The traditional sequential courses, that is college algebra, trigonometry, analytic geometry and the calculus.

2. A series of courses, which treat the separate disciplines for brief periods each in succession and then repeat the process in a sort of spiral organization.

3. A single course extending over a period of two or more years in which the entire subject matter is treated as a correlated or integrated unit.

4. A modified correlation or integration in which two or more phases of the subject matter are integrated over a certain period while other phases are integrated over another period. For example, college algebra and trigonometry may be integrated in a one semester course and analytic geometry and calculus over another semester or two semesters.

The last three of these ways of organization could be classified as general mathematics. One of the main apparent disadvantages is the difficulty of the student in transferring to an institution which uses a different organization. The best type of organization is not known. As was stated above in dealing with general mathematics for general education, there is probably no best course and the best method of attack at present is again through some type of evaluation program. Discussion of procedures would probably be about the same as that included above; it will not be repeated here.

To summarize the discussion of the various kinds of courses in general mathematics, it seems probable that to begin a program of improvement we should:

1. attempt to clarify the goals of a course or courses in general mathematics (they will be different of course for different groups)

2. collect and summarize evaluative evidence already available

3. improve existing evaluative devices and develop new ones to provide information on student progress relative to common goals

4. collect and interpret evidence on the changes induced in students subjected to various programs in general mathematics relative to common goals and

5. develop techniques for integrating instruction and evaluation to their mutual improvement.

Only by some such scheme will we be able to judge and compare objectively the various types of courses that are being offered. Otherwise we will be limited to judgments based on opinion and experience which at best will be of a highly subjective nature.

DEFICIENCIES OF COLLEGE FRESHMEN IN ARITHMETIC: DIAGNOSIS AND REMEDY

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Pensacola Junior College, Pensacola, Florida

Even before the recent increase in college enrollment brought with it an increase in published comments relative to the deficiencies of college freshmen, it must have been apparent to college instructors that many freshmen have always been seriously deficient in reading skill, mechanics of English, study habits, and the fundamentals of arithmetic. However, most published comments have been devoted to fixing the blame for such deficiencies on the agency responsible for the previous instruction of the student; few, indeed, have dealt with means of assisting the student to attain a maximum development after entrance into college.

At the end of this report is a list of outstanding contributions to current publications which deal largely with the diagnosis and remedial treatment of the weaknesses of college freshmen in arithmetic. Particularly noteworthy among these articles is that describing the remedial program in mathematics administered by Wolfe at Brooklyn College both because of the thoroughness with which the program was planned and the decisive way in which his results indicate that proper remedial measures are in order and demonstrably beneficial.

The discouraging aspect of these studies is that, although a serious problem has been recognized for more than a quarter of a century, only a few systematic and effective attempts at a solution have been reported. For at least as long, much of the instruction in mathematics has been under fire for its emphasis upon bare mechanical skills attained by rote drill, with an almost complete disregard of understanding and meaning. Apparently to little avail, intelligent leaders have advocated for years that an attempt be made to clothe mechanical skill with meaning by an intuitive approach in teaching and by the development of the history and background of mathematical processes, along with their social and scientific applications—convinced that understanding will prove as lasting as skill alone has been ephemeral.

Summary of Conclusions from Studies Considered

1. Examination of many articles relating to arithmetic tests administered to college freshmen has inexorably emphasized the unhappy fact that thirty to forty per cent of the freshmen in most sections of the country are inferior to the average eighth grade student in computational skill.

2. Arithmetic topics of greatest difficulty are those related in any way at all to fractions, with lack of real understanding of the processes involved in fractions at the basis of the trouble.

3. Remedial programs at some colleges have been instituted and have accomplished their purposes, for the types of errors that freshmen make with arithmetic important to their success in college are limited in number and have been eliminated in some cases, temporarily at least, by a remedial program of two classes a week for six to eight weeks in addition to the regular class periods. Remedial programs in arithmetic should be undertaken by both high schools and colleges.

4. Little has been done to analyze freshman difficulties in mathematics at the college level comparable to those efforts of Butler, Buswell, Brueckner, Orleans, Ohlsen, and any number of others at the lower school levels. Guiler at Miami (Ohio) University, Keller, Shreve and Remmers at Purdue, and Wolfe at Brooklyn College have made important beginnings.

5. Probably colleges are doing more in the way of diagnosis and remedy for freshmen than appears in current magazines, but no standardized diagnostic test, either group or individual, designed exactly to fit college freshmen in mathematics has been placed on the market, so that the instructor has difficulty in obtaining a diagnostic measurement meaningful and useful to him.

6. It appears that a test covering a review of the simpler mathematics of high school is the best single criterion for sectioning freshmen in mathematics, and that the best single criterion for predicting success with freshman mathematics would be a test given at the end of two or three weeks of review of the arithmetic and high school algebra needed in the freshman course.

7. No satisfactory aptitude test in mathematics has been devised for use with college freshmen.

8. Not only are college freshmen, far removed in point of time from formal arithmetic, deficient in it; even elementary and high school pupils, fresh from the study of arithmetic, are unable to recognize or recall the basic concepts that have been authoritatively proposed as "musts," while skills possessed by high school pupils at graduation fall short of a mastery of the rudimentary fundamentals of computation necessary for success in college mathematics and probably necessary for competent citizenship.

Observations and Implications

I. Regarding High School Procedures

1. Emphasis on the development of mathematical skills in ele-

mentary and high schools does not foster the retention of those skills or insure the ability to apply them. It is quite likely that the failure to stress the development and understanding of mathematical concepts accounts at least in part for the student's meager residuum of learning.

2. Although it is by no means the whole story, in no study of freshman deficiency is there any mention of the fact that learning is not permanent. The public school curriculum is overloaded with courses of which it is impossible for a student to maintain a high level of mastery without constant review. Perhaps luckily there is no one with a standardized test attempting to ascertain how much college graduates remember about differential equations a year after they step off the rostrum with a degree.

3. Since the turn of the century, the nature of the school population in high school and college has changed drastically. Relatively larger numbers of people are going to high school and college than ever before and many of the poorer students who formerly dropped out to start work are now going on through high school and college. Many of these high school pupils cannot or will not accept and master a college preparatory course. The high school faculty and administration have more than they can do to maintain an adequate non-college-preparatory course for the great majority without additional concern for the minority who are going to college and who are likely to make out in any case.

4. There are steps that the high school administration might take to avoid in part the complaints of irate college instructors and parents with children not properly prepared for college in the fundamentals of reading, writing and arithmetic. The high school teacher of the "tool subjects," the principal and the parents of those children who have the financial means or the mental capacity for college should meet regularly or communicate regularly in an effort to see that this group of students takes the proper courses for college preparation, that it goes beyond the minimum required for recommendation to college, and maintains not less than a "B" average or whatever grade is considered really sufficient for college success. When one of this group of pupils fails to attain distinctly superior achievement in any of the college preparatory subjects of importance, the teacher or principal should notify the parent in order that the latter may recognize the situation in time to accept some of the responsibility. These pupils should be held to rigid college entrance requirements as nearly as possible.

5. High school seniors who propose to enter college should not be allowed to graduate until they have passed a test or taken a stiff

course in the fundamentals of English composition, reading and arithmetic—with emphasis on the meanings, understandings and applications they will need most in college and in some phases of business life.

6. One alternative to such action might be to establish, between high school graduation and college, an intermediate school or course for the preparation of those graduates who expect to enter college and who did not acquire the equipment for college success while in high school. In summer school immediately after graduation a remedial, orientation and guidance course (or courses) for students intending to enter college in the fall could well become a regular part of the high school curriculum or of the extension service of the state university. Strong emphasis should be placed on how to study. The successful completion of such a course or courses might be made prerequisite for recommendation to college.

7. A proposal which is receiving some attention at present is the establishment of a dual curriculum in high schools to provide for both college and non-college preparation in mathematics.

II. Regarding Colleges

1. Diagnostic tests in mathematics, both group and individual, should be designed exactly to fit the varied needs of college freshmen. At least one group test containing items ranging in difficulty from about thirty per cent to fifty per cent in the number of students missing each should be constructed and used for preliminary diagnosis in isolating cases of extreme deficiency. This test should not contain whole numbers, except perhaps denominate numbers, since the diagnosis of operations with whole numbers can be effected as well by means of decimals, time being so important a factor. The large emphasis throughout the whole series of tests should be upon fractions, common and decimal.

2. A follow-up diagnostic study should be made of a representative sample of students failing college mathematics in an attempt to determine the reasons for failure. The study should include tests and questionnaires on I.Q., personal adjustment, social adjustment, deficiency in mathematical background, health, leisure time activities, finances, et cetera.

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RESEARCH AND TEACHING ASSISTANTSHIPS

Graduate assistantships in the College of Education, University of Illinois, will be offered to superior graduate students in:

Agricultural education
Child development
Curriculum
Educational psychology
Guidance
Home economics education
Industrial education
Measurement and evaluation
School administration and supervision
Social foundations of education
Social psychology and its applications to education
Special education of exceptional children
Statistical and research methods
Teaching at elementary or secondary level
Teacher education and teacher personnel problems

Preference will be given to young persons who in previous graduate study have demonstrated the capacity for high grade graduate work. For many of these posts, a premium is also placed upon a few years of successful professional experience. A small number of places will be reserved for beginning graduate students of extraordinary promise.

These appointments will become effective September 16, 1950. Appointees will be paid $1200 for nine months or $1400 for eleven months half-time duty. They will be granted free tuition and fees in the Graduate College, where they will be permitted to register for three-fourths of a normal full-time schedule of graduate study.

Further information and application forms may be obtained from Professor F. H. Finch, 105 Gregory Hall, University of Illinois, Urbana, Illinois.

Alcohol blow torch, an improved type for use in soft soldering, has a gun grip plastic handle for easy holding and a sliding windshield to permit its use indoors or outdoors with equal efficiency. It produces a flame of over 2700 degrees Fahrenheit.

EASTERN ASSOCIATION OF PHYSICS TEACHERS
ONE HUNDRED SEVENTY-SECOND MEETING

Saturday, May 14, 1949
Providence College, Providence, R. I.

10:00 A.M. Greetings—Very Rev. Robert J. Slavin, O.P., President.
10:15 A.M. Some Physical Aspects of Micro-Wave Projection,
Mr. Thomas Rogers,
Air Matériel Command,
Cambridge, Mass., Field Station.
11:00 A.M. The Science Teacher and the Social Implications of Science,
J. Edward Casey,
Asst. Prof. of Education,
R. I. State College, Kingston, R. I.
Professor Casey will speak for approximately 35 minutes.
He then desires audience participation in a discussion of his topic.
12:00 M. The Vice-president's annual address.
Miss Anna E. Holman,
The Winsor School, Boston, Mass.
12:30 P.M. Business Meeting, election of officers.
1:15 P.M. Lunch
2:15 P.M. Apparatus Committee members display their favorite teaching devices.
Members of the E.A.P.T. are urgently requested to assist in this most useful work.
Bring your pet demonstrations to this meeting.

Officers for the Association for 1948–1949:
President—Raymond F. Scott, Rindge Tech., Cambridge, Mass.
Vice-president—Anna E. Holman, Winsor School, Boston, Mass.
Secretary and Treasurer—Albert R. Clish, Belmont High School, Belmont, Mass.

REPORT OF THE ONE HUNDRED SEVENTY-SECOND MEETING OF THE E.A.P.T.

The meeting was held in the large lecture hall of the new science building. The building is known as the Albertus Magnus building and is named in honor of the 13th century monk.

The Very Rev. Fr. Slavin, President of the College greeted the Association and wished the Association a pleasant and profitable meeting at Providence College. He called attention to some of the facts in the life of Albertus Magnus. He was the only one to be called "the great" during life. Fr. Slavin ended his remarks with the quotation, "no one is the master of the natural sciences—we must leave our mind open for our experiments."

The first regular speaker of the morning program, the main speaker for the day, was Mr. Thomas Rogers of the Air Matériel Command. His talk concerned itself with "Some Physical Aspects of Micro-Wave Propagation" in a very narrow band of the high frequencies.

Some Physical Aspects of Micro-Wave Propagation

Mr. Thomas Rogers

Because of the extreme breadth of the field it is necessary to limit the discussion this morning to only a single facet of the subject or to give a very general survey of the one meter to one millimeter region.

Attenuation Due to Oxygen

The first thing to be considered is the attenuation due to oxygen under stand-

ard conditions as to temperature and pressure. The absorption of energy due to any gas is a complex function of frequency. The speaker has particular interest in the very low wavelength end of the one meter to one millimeter band. His discussion concerned itself particularly with the 10,000 to 30,000 megacycle section.

The figure showing oxygen attenuation, Figure 1, indicates a sharp rise in the attenuation due to oxygen as one passes from the 6 cm. band to the 1.5 cm. band.

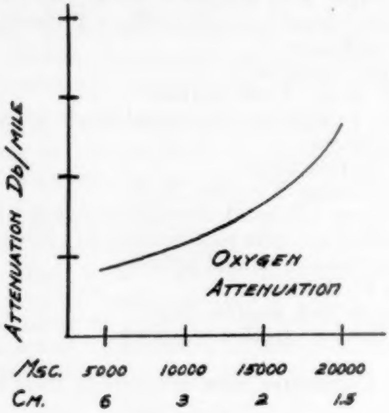


FIG. 1.

Attenuation Due to Uncondensed Water Vapor

The water molecule has an electrical polarity and absorbs electromagnetic energy radiation strongly at certain frequencies. Figure 2 shows the water vapor attenuation. Here, too, it will be noticed that attenuation increases as the wavelength lessens.

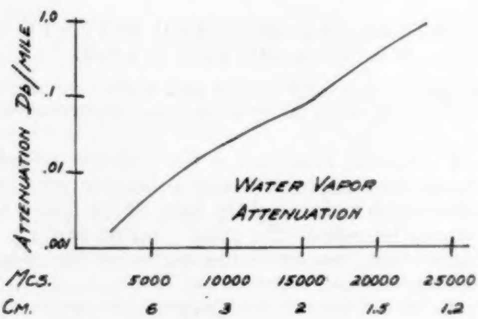


FIG. 2.

Total Gaseous Attenuation Under Standard Conditions

The attenuation along the line of the transmission due both to the oyxgen absorption and the saturated water vapor content is additive and it is always present in addition to any particle scattering effects due to mist, fog, rain, etc.

In addition to the oxygen attenuation and the water vapor attenuation one must also keep in mind the normal inverse squared distance loss. This loss is indicated in the following formula:

$$P_R = \frac{P_T \cdot A^2}{\lambda^2 \, d^2}$$

P_R is the received power
P_T is the transmitted power
A is the effective area of the transmitting antenna
λ is the wavelength
d is the transmitted distance

Variation of Gaseous Attenuation with Changes in Pressure and Temperature

The assumption that standard conditions as to gaseous attenuation, and water vapor attenuation must be modified appreciably as the conditions are not standard throughout the path of the transmission. Water vapor may be expressed in terms of the ratio of the water vapor pressure to the total atmospheric pressure with altitude. This is shown in Figure 3.

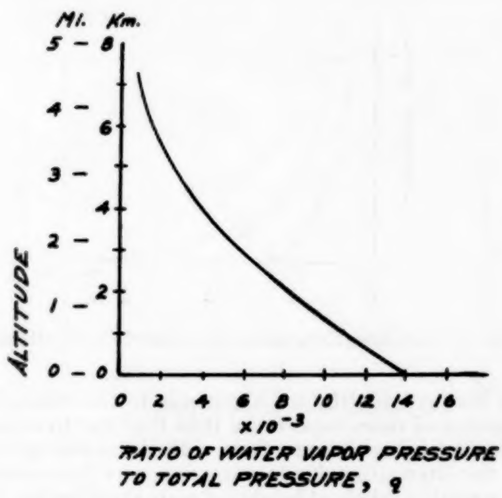


FIG. 3. Average variation of "q" with altitude.

The volume ratio of oxygen to the entire atmosphere remains constant at 0.2095 to the height of about 20 kilometers. At this point it begins to decrease roughly as the $\frac{4}{3}$ power of the height. Up to 20 kilometers of elevation, the attenuation due to oxygen, then, is directly proportional to the pressure and also proportional to another factor. Figure 4 shows the total atmospheric pressure vs. altitude.

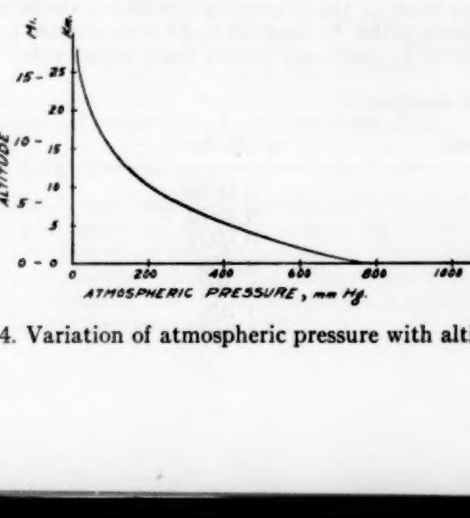


FIG. 4. Variation of atmospheric pressure with altitude.

Altitude Variation of Gaseous Attenuation

It is possible to determine the average attentuation for a given transmission distance as a function of temperature and pressure and consequently of altitude. Three curves: for oxygen alone, for water vapor alone, and for oxygen and water vapor combined are shown in Figure 5.

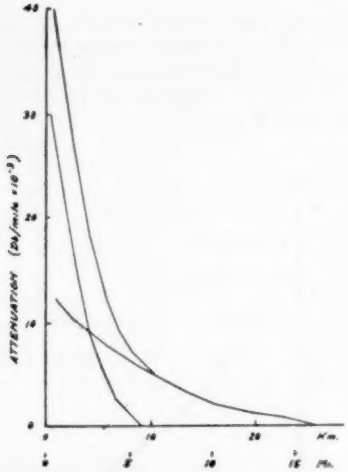


FIG. 5. Gaseous attenuation as a function of altitude.

It is apparent that at low altitudes, about one to two miles, the attentuation due to water vapor is of more importance than that due to oxygen, but falls off very rapidly with increasing altitude. Even with above average water vapor content conditions, the attenuation due to water vapor for transmissions of less than 1000 miles is apparently neglible at heights of more than 5 miles. Above the height of about 5 miles, practically all the attentuation is caused by oxygen.

In actual practice, exact interpretation of these results is far more difficult, for it must be emphasized that the curves are for average conditions. Conditions may exist that change the attenuation from a value much less than those indicated to up to three times the indicated values. These constant changes are found up to 5 miles in elevation. Above this height, the curves should become more generally useful, for the temperature and pressure variations do not act as energetically.

Since transmission paths, in general, do not follow a path of constant height with respect to sea-level, γ, the absorption coefficient varies to a large measure over the transmission paths. In long air-to-air transmission paths, the attenuation over the center of the path may have a much higher value.

Attenuation Due to Rainfall

p (mm/hour)	γ_R (db/km)	γ_R (db/mile)
0.25	0.0058	0.0093
1.25	0.0372	0.0600
2.50	0.0927	0.149
12.50	0.558	0.900
25.00	1.398	2.250
50.00	3.026	4.870
100.00	6.401	10.30

During rainfall, the existing total attenuation is made-up of the oxygen factor, the water vapor factor, and the attenuation due to the presence of liquid drops. The rainfall attenuation results from the scattering of the incident energy as well as the absorption of the individual drops.

The table above shows the attenuation, γ_R:

Attenuation, γ_R, in db/km and db/mile at 18° C for λ 2.15 cm. as a function of rainfall intensity p.

Expected Rainfall Intensities

It seems that the most meaningful manner for expressing rainfall attenuation values for the 1.15- to 2.3-cm. region is to express the rainfall attenuation values as a function of their expected occurrence in the year. From the table and from the following, Figure 6, it is easily seen that, for distances over ten miles, the rainfall attenuation forces the use of much greater transmitting power. Operating reliability is therefore much reduced.

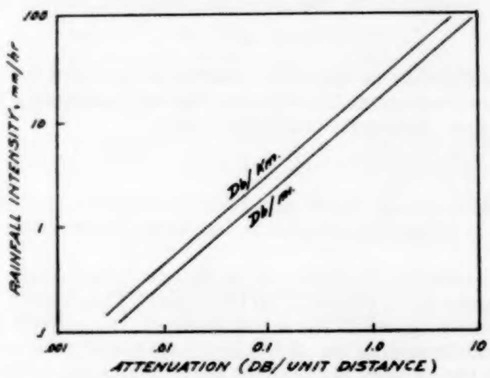


FIG. 6. Attenuation as a function of rainfall intensity.

Rainfall Attenuation Versus Path Length and Geography

The forecasting of attenuation due to rainfall in paths involving air-to-air and air-to-ground links is not easy. There is no simple variation of the attenuation medium with height. The variation to be found in rainstorm altitudes is in the order of tens of thousands feet. There is only one definite limiting statement that can be made and that is that rain clouds do not as a rule reach heights greater than 6 miles. From the above, it is readily seen that air-to-air links at high altitudes suffer less from rainfall attenuation. However, long air-to-air transmission paths do not offer full altitude advantages for a large portion of the transmission path is close to the earth.

Also a factor in the calculation of rainfall attenuation compared with gaseous attenuation is the unpredictable homogeneity of the transmission path. The gaseous absorption per unit length of path remains rather constant along the path length. This is seldom true in the case of rainstorms. The intensity of rainfall may vary a great deal even within a distance of one mile.

Total Gaseous and Rainfall Attenuations

A better picture of the total expected attenuation in the 2.15- to 2.3-cm. region may be expressed best, possibly, by determining the increase in transmitting power over calculated free-space amount necessary. The increase in transmitter power as a function of one-way transmission distance which is required to maintain fixed free-space operating conditions is expressed for various percentages of reliable operating time in the following figure:

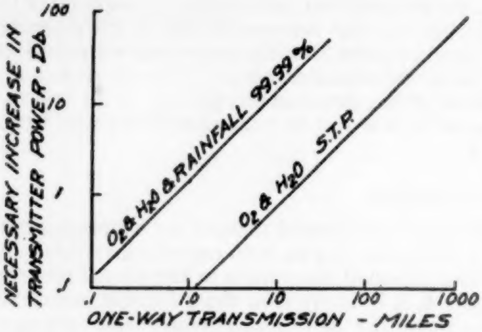


FIG. 7. Necessary increase in transmitter power to retain free space carrier-to-noise conditions vs. transmission distances for two reliabilities.

Extreme high reliability of operation cannot be expected for other than relatively short distances except at the expense of greatly increasing the transmitting power above the mean-free-space calculated value.

Other Effects

Other propagation effects which may be mentioned in conclusion are those of attenuations due to hailstones, ice-clouds, fog, snow, interference type fading and refraction.

The assistant professor of education at Rhode Island State College, Mr. J. Edward Casey, spoke quite generally on the topic, "The Science Teacher and the Social Implications of Science" for a few minutes. He seemed to feel that education for all should be science for all but hastened to add that more science in the curriculum is not the answer. He believes that 75% of the students do not need the conventional science courses but need in their place suitable unit materials from all fields.

The Vice-president's annual address was quite informal. Miss Anna E. Holman raised several questions and suggested some answers to the same. She elaborated upon her answers in a very personal way as only Miss Anna E. Holman can do.

The questions Miss Holman raised follow:

Where are the teachers coming from?

What are you doing about it?

How many are under thirty years of age?

What are you doing for the real scientists?

What are you doing about the energy from the nucleus?

In the last few minutes before lunch, there was held a short business meeting at which Mr. John J. Bremman suggested a slate of officers for the next year. His slate was accepted and the secretary was instructed to cast a single ballot for the slate as read. The following were elected for the year 1949–1950.

President—Mr. Everett F. Learnard, Norwood High School, Norwood, Mass.

Vice-president—Mr. Charles S. Lewis, Brighton High School, Brighton, Mass.

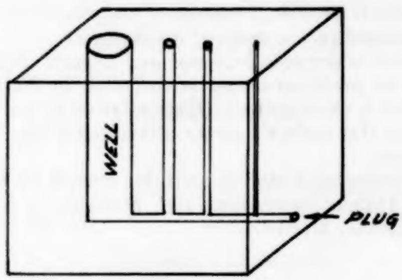
Secretary and Treasurer—Mr. Albert R. Clish, Belmont High School, Belmont, Mass.

Report of the Apparatus Committee

Negative Capillarity

Miss Helen Gollette, a student in the physics class of Mr. Kenneth L. Goding, and valedictorian in the Class of 1949 at Attleboro High School, demonstrated a simple device to show negative capillarity. A plastic block, having a small well

near one end several drill holes of ever decreasing diameter communicating with the well, was filled with mercury. Care must be exercised in the drilling of the several holes so that a smooth wall permits easy vision. The device is simplicity in itself and works well. The general arrangement is shown in the following sketch:



SKETCH – PLASTIC BLOCK TO SHOW NEGATIVE CAPILLARITY

Cords, Discords, and Beats

Cords, discords, and beats were shown by means of the Knipp Tube by a student in Mr. W. Roscoe Fletcher's physics class at North High School located at Worcester, Mass.

Albert R. Clish, Sect.

THE TENTH SUMMER MEETING OF
THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS
THE UNIVERSITY OF WISCONSIN, MADISON
AUGUST 21, 22, 23, 24, 1950

The Tenth Summer Meeting of The National Council of Teachers of Mathematics will be held at The University of Wisconsin August 21, 22, 23, 24, 1950. An excellent program of addresses and panel and group discussions has been planned for arithmetic teachers and teachers of mathematics in the junior and senior high schools. Leaders in mathematics education from 27 states, the District of Columbia and the Canal Zone will appear on the program. New features of the program are the special sessions planned and carried out by the state councils in Illinois, Indiana, Iowa, and Minnesota. Each of these groups will present reports and lead discussions on problems with which their state organizations have been concerned in the past year. There will also be special emphasis on topics from the history of mathematics and topics of an expository nature in mathematics as well as the usual papers on teaching problems and discussions of new teaching aids.

The program includes special reports on new curriculum studies in New York, Minnesota, and Iowa; a section on solid geometry and several sections on plane geometry; reports on work in such cities as Cleveland, Baltimore, Wilmington (Del.), Hartford (Conn.), Los Angeles, Indianapolis, Omaha.

Requests for rooms in University Residence Halls should be addressed to John Mayor, North Hall, Madison 6, Wisconsin. Programs will also be sent upon request.

Water-timer, for use on the lawn hose, automatically cuts the water off after a pre-set quantity has passed through it, thus preventing over-watering. It is a small device which is inserted between the outlet faucet and the hose. By the turn of a knob, "untimed" water is delivered.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

Late Solutions

2177. *Earl Gose, Aberdeen, Washington.*

2178. *A. L. Leatherby.*

2182. *Warren Hulser, Hebron, Maine; Helen Scott, Mt. Pleasant, Iowa; and David Shepard, Florida A. and M. College.*

2183. *Norma Sleight, Winnetka, Ill.; M. Philbrick Bridgess, West Roxbury, Mass.*

2176, 7, 82, 3. *S. E. Field, Ironwood, Michigan.*

2167, 71, 2, 5, 6, 7, 8, 9, 82, 3. *G. B. Libby, San Francisco, Calif.*

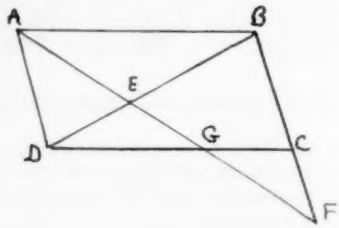
2183. *Dwight L. Foster, Florida A. & M. College.*

2180. *M. M. Dreiling, Collegeville, Ind.*

2055, 70, 1, 2, 3, 5, 6, 7, 8. *By Prasert Na Nagara, Bangkok, Thailand.*

2185. *Proposed by Warren E. Shingle, Houghton, N. Y.*

In a parallelogram $ABCD$, an arbitrary line through A cuts BD at E, BC at F and DC at G, prove $1:AE = 1:AF + 1:AG$.



Solution by Max Beberman, Shanks Village, New York

Triangles ABE and GDE are similar; thus

$$GD:AB=GE:AE. \tag{1}$$

Since FC is parallel to AD and CD equals AB, we have

$$AG:AF=GD:CD=GD:AB \tag{2}$$

From (1) and (2) we find

$$GE:AE=AG:AF \tag{3}$$

or

$$(GE+AE):AE\equiv AG:AE=AG:AF+1$$

or dividing through by AG,

$$1:AE=1:AF+1:AG.$$

Other solutions were also offered by: Lawrence Jones, Woodstock, Conn.; Aaron Buchman, Buffalo, N. Y.; W. J. Cherry, Berwyn, Ill.; M. M. Dreiling, Collegeville, Ind.; David Rappaport, Chicago, Ill.; A. MacNeish, Chicago, Ill.; L. J. Klosterman, Rochester, N. Y.; Dwight Foster, Florida A. & M. College; C. W. Trigg, Los Angeles City College; Norma Sleight, Winnetka, Ill.; Bernard Katz, Brooklyn.

2186. *Proposed by Adrian Struyk, Paterson, N. J.*

Using four fours in conjunction with decimal, radical and factorial notation,

(a) Express as many positive integers as possible in the form $(a+b)/(a-b)$. Example

$$2=(\sqrt{4}+\sqrt{.4})/(\sqrt{4}-\sqrt{.4}).$$

(b) Discover a relation having the form

$$(a+4)/(a-4)=(4+b)/(4-b)=(\sqrt{a}+\sqrt{b})/(\sqrt{a}-\sqrt{b}).$$

Solution by C. W. Trigg, Los Angeles City College

(a) No restriction is placed on the radical nor on the factorial notation, so any exponent may be used, e.g., $\sqrt[2/3]{4}=4^{3/2}=8$. Also subfactorials are permissible, such as 4 subfactorial $=4¡=2\times4+1=9$, $3¡=1\times3-1=2$, $2¡=0\times2+1=1$, and $1¡=1\times1-1=0$. We now generate chainwise as many integers as possible using combinations of the various operational symbols, but will represent a particular integer in only one of the many possible ways.

$4=4$, $\sqrt{4}=2$, $2¡=1$, $1¡=0$.

$4¡=9$, $\sqrt{9}=3$, $3!=6$, $6¡=25$, $\sqrt{25}=5$, $5¡=14$, $14¡=169$, $\sqrt{169}=13$.

$4!=24$, $24¡=529$, $\sqrt{529}=23$.

$4^{3/2}=8$, $8¡=49$, $\sqrt{49}=7$, $7¡=34$, $34¡=1089$, $\sqrt{1089}=33$.

$4^{4/2}=16$, $16¡=225$, $\sqrt{225}=15$.

$4^{5/2}=32$, $32¡=961$, $\sqrt{961}=31$.

$4¡=9$, $9^{3/2}=27$.

Thus using a single four and the necessary combinations of the operational symbols we now have representations of the integers

$$0,\cdots,9;\ 13,\cdots,16;\ 23,\ 24,\ 25,\ 27,\ 31,\ 32,\ 33,\ 34,\ 49 \tag{A}$$

and each of these is a possible value for a or for b. The process may be continued indefinitely.

Now if an integer $N=(a+b)/(a-b)$ and $a=b+2$, then $N=b+1$. Hence we

have immediately from set (A) the following values for N: 1, 2, 3, 4, 5, 6, 7, 8, 14, 15, 24, 26, 32 and 33.

If $a=b+1$, then $N=2b+1$, so from set (A) we have the additional values for N: 9, 11, 13, 17, 27, 29, 31, 47, 49, 63, 65, 67.

Indeed, $a:b::(N+1):(N-1)$, so for $N=10$, $33:27::a:b$.

We now introduce the decimal notation and note that any of set (A) may be converted to a decimal by prefixing a decimal point. Thus we find additional values for a or b, $.[(\sqrt{\dot{4}})1]=1/9$, $.\sqrt{\dot{4}}=2/9$, $.\sqrt{\dot{4}}\text{¡}=1/3$, $.\dot{4}=4/9$, and $\sqrt{.\dot{4}}=2/3$. No new values of N result.

(b) If $M=(a+4)/(a-4)=(4+b)/(4-b)=(\sqrt{a}+\sqrt{b})/(\sqrt{a}-\sqrt{b})$, then $ab=16$. Hence, $a=\sqrt[2/3]{4}=8$, $b=\sqrt{4}=2$ or $a=\sqrt[1/2]{4}=16$, $b=(\sqrt{4})\text{¡}=1$. The corresponding values of M are 3 or 5/3.

A solution was also offered by the proposer.

2187. *Proposed by Adrian Struyk, Paterson, N. J.*

A quadrilateral $ABCD$ has sides whose lengths are the roots of the equation

$$(x^2-2mx+p^2)(x^2-2nx+q^2)=0$$

where $n^2-n^2=p^2-q^2$. Find the area of $ABCD$.

Solution by the proposer

The general formula for the area S of a plane quadrilateral with sides a, b, c, d, semiperimeter s, and opposite angles A, C is

$$S^2=(s-a)(s-b)(s-c)(s-d)-abcd\cos^2(A+C).$$

Let $x^2-2mx+p^2=0$ have roots a, b; $x^2-2nx+q^2=0$ have roots c, d. Then

$$a+b=2m, \quad ab=p^2, \quad c+d=2n, \quad cd=q^2.$$

Now

$$(a-b)^2=(a+b)^2-4ab=4m^2-4p^2=4(m^2-p^2),$$
$$(c-d)^2=(c+d)^2-4cd=4n^2-4q^2=4(n^2-q^2).$$

Since

$$m^2-n^2=p^2-q^2 \quad \text{it follows that} \quad m^2-p^2=n^2-q^2.$$

Therefore

$$(a-b)^2=(c-d)^2,$$

so that

$$a-b=c-d, \quad \text{or else} \quad a-b=d-c.$$

Hence

$$a+d=b+c, \quad \text{or else} \quad a+c=b+d,$$

that is, the sum of two sides is equal to the sum of the other two sides. Each of these sums is, therefore, the semiperimeter.

From

$$a+d=b+c=s$$

we get

$$a=s-d, \quad d=s-a, \quad b=s-c, \quad c=s-b.$$

Then

$$(s-a)(s-b)(s-c)(s-d)=abcd.$$

The same result follows, of course, from $a+c=b+d$. Substituting in the area formula,

$$S^2=abcd[1-\cos^2 \tfrac{1}{2}(A+C)]=p^2q^2 \sin^2 \tfrac{1}{2}(A+C).$$

Therefore the area of $ABCD$ is

$$pq \sin \tfrac{1}{2}(A+C).$$

Mr. Trigg in offering a solution imposed the condition that the quadrilateral be inscriptable. Using the Brahmagupta formula he found the area to be $\sqrt{abcd}$.

2188. *Proposed by Howard D. Grossman, N. Y.*

What is the probability that three or more children in a family of eight children have the same birthday?

Solution by Max Beberman, Shanks Village, New York

The problem may be viewed as one of determining the probability of drawing a particular sample of eight objects from a population having the following distribution: it is comprised of eight identical sets each containing 365 objects numbered consecutively from 1 to 365. The sample is drawn such that one object is selected at random from each set. What is the probability of drawing a sample that will contain at least three objects bearing the same number?

This probability (P) may be ascertained by calculating the probability (P') of drawing a sample in which no more than two of the objects have the same number. Then $P=1-P'$.

Now there are $(365)^8$ possible samples which may be drawn from this population. Of these, a samples contain eight differentialy-numbered objects, b samples contain only one pair of objects with the same number, c samples contain just two pair of objects bearing the same number, d samples with three pair of objects bearing the same number, and e samples with four pair of objects bearing the same number.

Now

$$a={}_{365}P_8, \qquad b={}_{365}C_1\cdot{}_{364}C_6\cdot\frac{8!}{2!}\cdot \qquad c={}_{365}C_2\cdot{}_{363}C_4\cdot\frac{8!}{2!2!},$$

$$d={}_{365}C_3\cdot{}_{362}C_2\cdot\frac{8!}{2!2!2!}, \qquad e={}_{365}C_4\cdot\frac{8!}{2!2!2!2!}.$$

Then

$$P=1-P'=1-\frac{a+b+c+d+e}{(365)^8}.$$

Evaluation, using six-place logarithms, yields $P=.00358$.

The general procedure for obtaining the above combinatorial expressions may be derived from an explanation for finding d. There are ${}_{365}C_3$ ways of drawing three pair of objects, each pair denoted by a different number. The other two objects may be selected from the remaining 362 objects in ${}_{362}C_2$ ways. Now each of these ${}_{365}C_3\ {}_{362}C_2$ combinations of eight objects may be permuted in 8! ways. However not all of these permutations are distinct since three pair are identically numbered. Thus we reduce the number of dividing the total by 2!2!2!.

Editor's question—Is the above solution correct?

2189. *Proposed by Norman Anning, University of Michigan.*

Prove the identity

$$\sin p \sin q + \sin r \sin (p+q+r) = \sin (p+r) \sin (q+r).$$

Solution by S. E. Field, Gogebic Junior College, Ironwood, Mich.

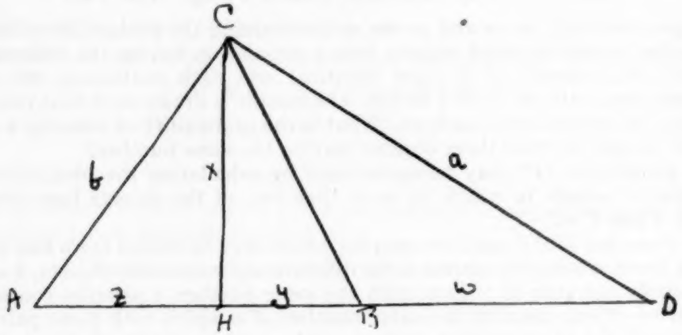
Using the familiar form for transforming the product of the sines to a difference, we have, applying to both members,

$\frac{1}{2}[\cos(p-q)-\cos(p+q)]+\frac{1}{2}[\cos(p+q)-\cos(p+q+2r)]=\frac{1}{2}[\cos(p-q)-\cos(p+q+2r)]$
which is an identity.

Other solutions were also offered by: Bernard Katz, Brooklyn, N. Y.; Max Beberman, Shanks Village, N. Y.; Norma Sleight, Winnetka, Ill.; C. W. Trigg, Los Angeles City College; G. L. Tuttle, Mt. Pleasant, Iowa; David Rappaport, Chicago, Ill.; A. MacNeish, Chicago, Ill.; Aaron Buchman, Buffalo, N. Y.; and Nicholas Kushta, Arlington Heights, Ill.

2190. ***Proposed by Adrian Struyk, Paterson, N. J.***

In triangle ABC, CH is the altitude to AB, and $\angle C=45°$. It is required that the altitudes AH, BH, and CH, have integral lengths. Without use of trigonometry show how to determine integral lengths.



Solution by C. W. Triggs, Los Angeles City College

Perpendicular to AC draw CD meeting AB extended at D. Let $CH=x$, $BH=y$, $AH=z$, $BD=w$, $CD=a$, and $CA=b$. Now CB is the bisector of angle DCA, so $a/b=w/(y+z)$. By the Pythagorean theorem, $x^2+z^2=b^2$ and $(w+y+z)^2=a^2+b^2$ $=b^2[w^2/(y+z)^2+1]=(x^2+z^2)[w^2+(y+z)^2]/(y+z)^2$. Furthermore, $x^2=z(w+y)$. Eliminating w, we have

$$(x^2+z^2)[x^2+(y+z)x-yz][x^2-(y+z)x-yz]=0. \qquad (1)$$

Hence

$$x=\pm[(y+z)\pm\sqrt{y^2+6yz+z^2}]/2.$$

The solution of $y'+6yz+z^2=N^2$ in integers is $y=K(m^2-n^2)$, $z=K(2mn+6n^2)$, $N=K(m^2+6mn+n^2)$, whence $x=K(m^2+4mn+3n^2)$. The three other solutions of (1) are extraneous. For example, when $K=1$, we have

m	n	x	y	z
2	1	15	3	10
3	2	45	5	36

If CH is exterior to ABC, by a similar procedure, we have

$$(x^2+z^2)[x^2+(z-y)x+yz][x^2-(z-y)x+yz]=0,$$

from which $z=K(m^2-n^2)$, $y=K(2mn-6n^2)$, $N=K(m^2-6mn+n^2)$, and x $=K(m^2-4mn+3n^2)$, $m>3n$. For example, when $K=1$, we have

m	n	x	y	z
4	1	3	2	15
7	2	5	4	45

The proposer and Norman Anning also offered solutions.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

2189. ***Roger Kennedy, David Kurtz, Richard Morrow, and Harold Dotts, of Arlington Heights, Ill.; Jack Trees, Winnetka, Ill.; Leo Michuda; Chicago; William Mulac, Chicago; Charles Goodman, Winnetka, Ill.; William Seiden, Winnetka, Ill.***

2185. ***Paul Wilson, San Francisco, Calif.***

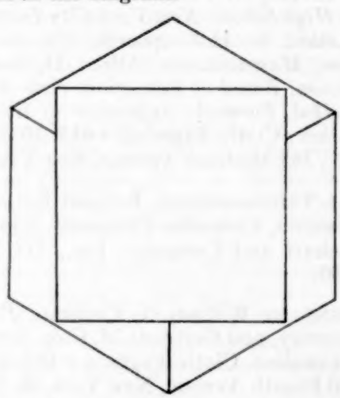
A Late Solution

2181. ***Proposed by Howard D. Grossman, New York.***

To cut a hole in a cube through which another cube of equal size can pass.

Solution by the proposer

If one cube rests horizontally with an edge toward the observer and is then tilted top forward toward the observer at an angle of 35°16′ ($\tan^{-1}1/\sqrt{2}$), then the nearest vertex will be directly in line with the remotest one and the diagonal joining them will be perpendicular to the observer. With this diagonal as an axis, a second cube with one face toward the observer can then be barely projected through the first cube as in the diagram.



Hugo Brandt, Chicago, also offered a solution in which he tilted the top at 45°.

PROBLEMS FOR SOLUTION

2203. ***Proposed by Alan Wayne, Flushing, N. Y.***

A cube with its edge m units long is painted red and then sliced into m^3 unit cubes. Find an albebraic formula for the number, n, of these unit cubes each of which has precisely k faces red.

2204. ***Proposed by Francis L. Miksa, Aurora, Ill.***

In the linear equation $ax+by=(C+z)$, with z taking on positive values, $1, 2, 3, \cdots, n$, what is the minimum value of C in order that the equation can always have a solution in positive integers x, y, for any given value of z?

2205. ***Proposed by Michael Schwartz, Kingston, N. Y.***

If a line from vertex C of triangle ABC, bisects the median from A it divides the base, AB, in ratio 1:2.

Is this an original theorem of geometry?

2206. *Proposed by Norman Anning, University of Michigan.*

A zigzag from $0(o, o)$ to $P(1, p)$ to $Q(q, o)$ to $R(4, r))$ is made so as to have two right angles. If $p=2\cos A$, then $-r=2\cos 3A$.

2207. *Proposed by Norman Anning, University of Michigan.*

Show how to trisect a given angle by use of two carpenter's squares.

2208. *Proposed by Julius Sumner Miller, New Orleans, La.*

Show that the ratio of the distances described by a falling body during the $(n-1)$th and the nth seconds is $(2n-1)/(2n+1)$.

BOOKS AND PAMPHLETS RECEIVED

MODERN CHEMISTRY, Revised Edition, by Charles E. Dull, *Late Head of Science Department, West Side High School, Newark, New Jersey;* William O. Brooks, *Chairman, Science Department, Technical High School, Springfield, Massachusetts;* and H. Clark Metcalfe, *Science Department, Brentwood High School, Pittsburgh, Pennsylvania.* Cloth. Pages xi+564. 15×23.5 cm. 1950. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $3.16.

SCIENCE FOR BETTER LIVING, by Paul F. Brandwein, *Chairman of the Science Department, Forest Hills High School, New York City Instructor, Teachers College, Columbia University;* Leland G. Hollingworth, *Director of Science, Brookline Public Schools, Brookline, Massachusetts;* Alfred D. Beck, *Science Supervisor, Junior High School Division, Board of Education, New York City;* and Anna E. Burgess, *Directing Principal, Formerly Supervisor of Elementary Science, Board of Education, Cleveland Ohio.*, Cloth. Pages xii+643. 16×24 cm. 1950. Harcourt, Brace and Company, Inc., 383 Madison Avenue, New York 17, N. Y. Price $3.28.

PLANE AND SPHERICAL TRIGONOMETRY, Revised Edition, by John A. Northcott, *Professor of Mathematics, Columbia University.* Cloth. Pages ix+234+94. 14×21.5 cm. 1950. Rinehart and Company, Inc., 232 Madison Avenue, New York 16, N. Y. Price $3.50.

EXPERIMENTAL DESIGNS, by William G. Cochran, *Professor of Biostatistics, The Johns Hopkins University,* and Gertrude M. Cox, *Director, Institute of Statistics, University of North Carolina.* Cloth. Pages ix+454. 14.5×23 cm. 1950. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.75.

FUNDAMENTALS OF ORGANIC CHEMISTRY, by James Bryant Conant, *President of Harvard University, Formerly Sheldon Emery Professor of Organic Chemistry,* and Albert Harold Blatt, *Professor of Chemistry, Queens College.* Cloth. Pages ix+413. 13.5×21 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.00.

SECOND-YEAR ALGEBRA, New Edition, by Raleigh Schorling, *Head of Department of Mathematics, The University High School and Professor of Education, University of Michigan;* Rolland R. Smith, *Coördinator of Mathematics, Public Schools, Springfield, Massachusetts;* with the coöperation of John R. Clark, *Teachers College, Columbia University.* Cloth. Pages xii+500. 13.5×20.5 cm. 1950. Yonkers 5, N. Y. Price $2.20.

NUMERICAL SOLUTIONS OF DIFFERENTIAL EQUATIONS, by H. Levy, M.A., D.Sc., F.R.S.E., *Professor of Mathematics at the Imperial College of Science, University of London,* and E. A. Baggott, M.Sc., A.R.C.S., D.I.C., *Lecturer in Mathematics, The Polytechnic Regent Street, London.* Cloth. Pages viii+238.

13×20.5 cm. 1950. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $3.00.

THEORY OF SETS, by Dr. E. Kamke, *Professor of Mathematics, University of Tübingen*, and Translated by Frederick Bagemihl, *Assistant Professor of Mathematics, University of Rochester*. Cloth. Pages vii+152. 12.5×19 cm. 1950. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $2.45.

INTRODUCTION TO SEMIMICRO QUALITATIVE CHEMICAL ANALYSIS, Revised Edition, by Louis J. Curtman, *Emeritus Professor of Chemistry, The City College of New York*. Cloth. Pages xvi+391. 13.5×20.5 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.50.

ELEMENTS OF ANALYTIC GEOMETRY, Third Edition, by Clyde E. Love, Ph.D., *Professor Emeritus of Mathematics in the University of Michigan*. Cloth. Pages xii+218. 13.5×20.5 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York, 11 N. Y. Price $2.75.

OUT OF MY LATER YEARS, by Albert Einstein. Cloth. Pages viii+282. 13.5×21.5 cm. 1950. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

REFLECTIONS OF A PHYSICIST, by P. W. Bridgman, *Harvard University, Cambridge, Massachusetts*. Cloth. Pages xii+392. 13.5×21.5 cm. 1950. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $5.00.

A SECOND COURSE IN ALGEBRA, Second Revision, by N. J. Lennes, and J. W. Maucker, *Dean, School of Education, Montana State University*. Cloth. Pages xv+522. 13×20.5 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $2.48.

ESSENTIALS OF ELECTRICITY FOR RADIO AND TELEVISION, New Second Edition by Morris Slurzberg, B.S., M.A., and William Osterheld, B.S., M.A., *Instructors of Electricity, Radio and Television, Wm. L. Dickinson High School, Jersey City, New Jersey*. Cloth. Pages xi+533. 15×23 cm. 1950. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $4.00.

DISCOVERY PROBLEMS IN PHYSICS, A WORKBOOK AND LABORATORY MANUAL FOR USE WITH ANY PHYSICS TEXT, Revised Edition, by Hallie F. Turner, *Head of Science Department, Eastside High School, Paterson, N. J.* Paper. Pages vi+354. 19×26 cm. 1950. College Entrance Book Company, 104 Fifth Avenue, New York 11, N. Y. Price $1.00 net to Schools (plus transportation charges).

NEW DISCOVERY PROBLEMS IN BIOLOGY, A COMPLETE STUDY GUIDE FOR USE WITH ANY BIOLOGY TEXTBOOK, by Grace Bagby, *Formerly Supervisor of Science, Flint Secondary Schools, Flint, Michigan;* Harold U. Cope, *Biology Department, Union High School, Upper Sandusky, Ohio;* C. S. Hann, *Head of the Biology Department, Central High School, Kansas City, Missouri;* and Mabel B. Stoddard, *Formerly of the Biology Department, Central High School, Flint, Michigan*. Paper. Pages viii+352. 19×26 cm. 1950. College Entrance Book Company, 104 Fifth Avenue, New York 11, N. Y. Price $1.00 net to Schools (plus transportation charges).

HOW SCIENCE TEACHERS USE BUSINESS-SPONSORED TEACHING AIDS. Report of a Study Made by the Advisory Council on Industry-Science Teaching Relations of the National Science Teachers Association. Paper. 36 pages. 21.5×27.5 cm. 1950. National Science Teachers Association, 1201 Sixteenth Street, Northwest, Washington 6, D. C. Price $1.00 per copy; subject to the following discounts: 2–9 copies, 10%; 10–99 copies, 25%.

CEBCO FILMGUIDES IN GENERAL SCIENCE were prepared by Myron F.

Boyer, *Director of Audio-Visual Aids, Muhlenberg Township High School, Laureldale, Pennsylvania.* Paper. 30 pages. 20×26 cm. 1950. College Entrance Book Company, 104 Fifth Avenue, New York 11, N. Y.

BIOLOGY IN REVIEW, by Phil R. Gilman, and Vincent R. Peterson. Paper. 405 pages. 12×19 cm. 1949. Lyons and Carnahan, 2500 Prairie Avenue, Chicago 16, Ill.

PRIMER OF COLLEGE MATHEMATICS, by John F. Randolph, Ph.D., *Professor and Chairman of the Department of Mathematics, University of Rochester.* Cloth. Pages xiii+545. 13.5×21 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.75.

FIRST PRINCIPLES OF ATOMIC PHYSICS, by Richard F. Humphreys, *Formerly Associate Professor of Physics,* and Robert Beringer, *Assistant Professor of Physics, Yale University.* Cloth. Pages ix+390. 15×23.5 cm. 1950. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $4.50.

ARITHMETIC FOR COLLEGES, by Harold D. Larsen, Ph.D., *Professor of Mathematics, Albion College.* Cloth. Pages xi+275. 13×20.5 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.75.

SMITH'S INTRODUCTORY COLLEGE CHEMISTRY, Third Edition, by William F. Ehret, *Professor of Chemistry, New York University.* Cloth. Pages viii+511. 17.5×25 cm. 1950. Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, N. Y. Price $4.25.

VECTOR AND TENSOR ANALYSIS, by Harry Lass, *Assistant Professor of Mathematics, University of Illinois.* Cloth. Pages xi+347. 15×23 cm. 1950. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $4.50.

BOTANY, AN INTRODUCTION TO PLANT SCIENCE, by Wilfred W. Robbins, *Professor of Botany,* and T. Elliot Weier, *Professor of Botany, College of Agriculture, University of California.* Cloth. Pages ix+480. 18×24 cm. 1950. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.00.

ESSENTIALS OF PLANE TRIGONOMETRY WITH TABLES, by Joseph B. Rosenbach, Edwin A. Whitman, and David Moskovitz, *Carnegie Institute of Technology.* Cloth. Pages viii+168+xv+118. 15×23 cm. 1950. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.70.

PLANE SPHERICAL TRIGONOMETRY, Third Edition, by H. L. Rietz, *Late Professor of Mathematics, University of Iowa;* J. F. Reilly, *Late Professor of Mathematics, University of Iowa;* and Roscoe Woods, *Associate Professor of Mathematics, University of Iowa.* Cloth. Pages xiii+205+72. 13.5×21 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $3.00, without tables $2.75.

PLANE TRIGONOMETRY, by John J. Corliss, and Winifred V. Berglund, *Chicago Undergraduate Division, University of Illinois.* Cloth. Pages xii+388. 14×21.5 cm. 1950. Houghton, Mifflin Company, 2 Park Street, Boston, Mass. Price $3.00.

MODERN SCIENCE TEACHING, by Elwood D. Heiss, Ph.D., *Professor of Science, New Haven State Teachers College, New Haven, Connecticut;* Ellsworth S. Obourn, M.A., *Head of the Science Department, John Burroughs School, Clayton, Missouri;* and Charles W. Hoffman, M.A., *Instructor in Physics and Physical Science, Temple University, Philadelphia, Pennsylvania.* Cloth. Pages viii+462. 13.5×21 cm. 1950. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $4.50.

BOOK REVIEWS

PLENTY OF PEOPLE, by Warren S. Thompson, *Scripps Foundation for Research in Population Problems.* Cloth. Pages xii plus 281. 10×15 cm. Revised edition. 1948. The Ronald Press Company, New York, N. Y. Price $3.50.

The explanatory sub-title well presents the scope of the subject matter presented in the book, "The world's population pressures, problems, and policies, and how they concern us." The author traces a clear picture of population trends in the world, and shows how life span expectancy has been on the upward trend in the progressive nations and how this has influenced the increase in population, which not even great wars have modified much, at least not for long periods of time. He also points out the difficulties involved in any effort to maintain a desirable population number. The book is at times depressing, especially when lack of effort to decentralize large urban centers is discussed in connection with danger of biological warfare and destruction by modern bombs. One of the best chapters is the one dealing with "minority groups," and how various governments have attempted to deal with the problem. Maps show how these groups are distributed in various countries. Causes for minority groups are racial differences, language, religion or social customs. The chief minority problems in the United States are associated with the negro population.

The author feels that the population pressure cannot be solved by migration to areas of less population pressure, he considers as only effective means the limiting of the size of family. He also points out that there are only three geographical locations where at present no population pressure exists; these are Brazil, Australia and New Zealand. By 1975 the United States will have a population of 165 million and this the author feels should be a desirable level to maintain for a satisfactory powerful nation assuring satisfactory economic status to its people.

The book is thought-provoking, it is well written and deserves a wide circulation not only in conservation and sociology groups but among the people as a whole.

J. E. POTZGER,
Butler University,
Indianapolis, Indiana

INTRODUCTION TO ANALYTIC GEOMETRY AND THE CALCULUS, by H. N. Dadourian, *Seabury Professor of Mathematics and Natural Philosophy, Trinity College.* Cloth. Pages x+246. 14×20.5 cm. 1949. The Ronald Press, New York 10, New York. Price $3.25.

The content of this book is somewhat out of the ordinary. It is, as the title would indicate, an *introduction*—by no means a complete treatment. In the preface the author indicates that the text could be used by students who take Freshman mathematics as a terminal course, as well as by those who expect to continue the study of mathematics. For the first group a skilled instructor would be needed in many places where the text discussion is extremely brief; for the second group either another specialized text would be needed, or a careful selection of material would need to be made from a standard calculus text.

Essentially, the book is in three parts, plane analytic geometry, differential calculus, and integral calculus, in that order. No material on trigonometry is used—the student can handle the work without this background. It of course follows that such topics as differentiation and integration of trigonometric functions are omitted. Other omissions from the usual treatment, indicative of the scope of the text, are: logarithmic and exponential functions, parametric equations, rotation of axes, integration by parts, multiple integration, partial differentiation, series, empirical equations.

Features which appealed to the reviewer included an excellent discussion of the application of calculus to physics, the discussion of the meaning of precision of measurement, the distinction between a necessary and a sufficient condition, a

better than usual presentation of the method for solving problems successfully. On the other hand, certain features did not meet with approval, although it must be pointed out that some of these may be a matter of personal opinion: on page 18 it is stated that the range of x is limited to the interval from -2 to 2, since values outside of this range make y, a specified function of x, imaginary (no restriction was made that y must be real for it to be a function of x); it is suggested that in deriving the equation of a curve the representative point (x, y) should be placed in the first quadrant (awkward if, for example, the condition is that the square of the abscissa added to the ordinate shall equal zero); the formula for the angle between two lines has nothing to show which angle is given; in the example on sound ranging it is stated that "the position of the gun lies on both . . . hyperbolas and . . . at their intersection point" which would imply a unique point (granted that an enemy gun can probably be located at only an intersection point); the statement on page 3 that the basic ideas of the calculus "are generally credited to Newton, and the notation to Leibnitz" may be somewhat unfair to Leibnitz' contributions; the symbol d^2y/dx^2 is not universally read "*d* two *y*, *dx* square"; on page 114 the author states that for functions which are continuous, with continuous derivatives, certain conditions are satisfactory criteria, whereas on the preceding page he has just illustrated a function, $y=x^4$, for which one of the conditions under discussion is necessary, but not sufficient—certainly to the student this is not a satisfactory criterion in this situation; the expression $\int_a^b f(x)\,dx$ is called the definite integral of $f(x)dx$, whereas many authors speak of it as the definite integral of $f(x)$.

The typography is good, no misprints were noted. There is a reasonably adequate supply of problems, with answers to the odd numbered exercises. There are few, if any, books available covering just this scope of material, hence this text is likely to receive favorable consideration in schools now offering or planning to offer a course of essentially this content.

CECIL B. READ
University of Wichita

ELEMENTS OF CALCULUS, By Thurman S. Peterson, *Associate Professor of Mathematics, University of Oregon.* Cloth. Pages ix+369. 16.5×24 cm. 1950. Harper and Brothers, New York 16, New York. Price $3.50.

This would be classified as a standard text in calculus in which the order of presentation follows the recent trend of presenting integration and applications early in the course. In fact the third chapter involves integration of powers and in the third and fourth chapter such applications as areas, volumes, centroids, moments of inertia, fluid pressure and work are treated for the case where the functions involved are algebraic polynomials only.

Differentiation formulas for the product, quotient, etc. and for transcendental functions are given after the two chapters on integration and applications. The text seems exceptionally well written. There is a very adequate supply of problems. Certain features which appealed to the reviewer are: the pointing out of the occasional value of using a constant in integration by parts; the warning about the choice of the proper sign for a radical when making a trigonometric substitution in the evaluation of definite integrals; the handling of the evaluation of the constants in the integration of rational fractions; and an excellent set of review exercises. Some teachers may object to the implication that a double integral and an iterated integral are the same thing, even though a footnote two pages later may clarify the situation.

Anyone contemplating the adoption of a text should by all means give careful consideration to this book. It seems definitely to rank among the better texts.

CECIL B. READ

COLLEGE ALGEBRA, by Earle B. Miller, *Professor of Mathematics, Illinois College* and Robert M. Thrall, *Associate Professor of Mathematics, University of Michi-*

gan. Cloth. Pages xvii+493. 14×20.5 cm. 1950. The Ronald Press, New York 10, New York. Price $3.75.

The authors state in the preface that they have attempted to avoid the complexity of the too advanced text without the sterility of an over simplified presentation. The text includes much more than many of the current books. There seems to be an ample supply of problems with answers provided to odd numbered exercises.

The authors have in general stated definitions in rigorous terms, for example: the definition of zero and negative exponents, the mantissa of a logarithm. Some topics are treated in considerably greater detail than usually found, for example the range of definition for a function. As examples of departure from the traditional treatment, one might mention the statement of such theorems as the remainder and factor theorem. These are given first for quadratic equations, then for third and fourth degree equations and finally for equations of the nth degree (some instructors may object to this method). Part III is entitled Functions of Integers, which includes such topics as sequences and series, mathematical induction and binomial theorem. One might wonder, however, why Chapter 14, (Interest and Annuities) is included in Part III, while Chapter 15 (Permutations and Combinations) is included in Part IV (Other Topics) when the reverse classification would perhaps seem more logical.

For teachers desiring a text which contains more material than can ordinarily be covered in a course, with the possibility of varied selection of topics to be presented, this book is well worth consideration.

CECIL B. READ

WEBS IN THE WIND, by Winifred Duncan. Cloth. Pages xv+387. 18.5×25 cm. 74 plates and 101 figures. 1949. The Ronald Press Company, New York. Price $4.50.

Here is a new volume in the Humanizing Science Series, edited by Jaques Cattell. This book will appeal not only to science teachers but also to all who have an interest in Nature, for *Webs in the Wind* introduces its readers to a new world—that of the web weaving spiders. The author admirably ignores conventional approaches and escorts her readers though this strange universe with a fresh approach to every problem. The reader triumphs with the author at every discovery and learns to respect these "miracles of condensation."

Spiders become more than gruesome spectacles. There are all kinds of spiders, more good than bad and predominantly harmless. Each species has a different set of habits and a particular type of web construction . . . complicated orbs and meshes designed to withstand the battering of wind and rain and the useless strugglings of entangled prey. There are descriptions, too, of the seldom seen mating dances.

The book is profusely illustrated by original drawings. These are referred to frequently in the text material which covers sixteen major research points, among which are such intriguing subjects as: life cycles, variations in food and methods of binding the prey, web building sites, variations in mating dances, birth of babies, changes in habits and body patterns at different seasons, danger signals, etc.

No book on spiders, of course, can neglect the black widow, but few include an account of midwifery to the babies of these infamous creatures. Mention is made of some of the close relatives of the spiders, and the final chapter lists a few general facts about spiders. The book also contains a glossary of spider anatomy, an annotated bibliography, and an index.

Webs in the Wind is written in a peculiar style, with scientific facts revealed through pleasant narration. This style, like the material, is new and refreshing.

GEORGE S. FICHTER
Miami University
Oxford, Ohio

MATHEMATICAL FOUNDATIONS OF STATISTICAL MECHANICS, by A. I. Khinchin. (Translated from the Russian by G. Gamow.) First American Edition. Pages VIII+174. 5×8. 1949. Dover Publications, Inc., N. Y. Price $2.95.

This small volume brings together in brief mathematical formulation the essential elements of statistical mechanics. It is precise and rigorous and eminently suited to the mature mathematician or mathematical physicist. The development is sound both historically and logically.

The treatment is directed to the mathematician primarily, and only secondarily to the physicist. The analytic apparatus is beautifully done, but the physicist would prefer a larger attention to physical phenomena.

The rise and development of statistical methods occupy a substantial place in scientific history. When the molecular theory of matter acquired status in physical thought, it was shortly discovered that the apparatus of differential equations was powerless. The reason is clear. Matter is a collection of a very large number of very small particles. The study of their infinite motions and interactions is an insurmountable task for the differential equations of classical mechanics.

The first investigations were Maxwell and Boltzmann. The first formal, systematic exposition of the foundations of statistical mechanics was by Gibbs ("Elementary Principles of Statistical Mechanics 1902"). In this exposition the foundations of statistical mechanics were established, centering around the problem of the interpretation of physical quantities by averages of their corresponding functions.

Fowler, v. Mises, Birkhoff and J. V. Neumann contributed substantially to its development. With the advent of atomic mechanics and quantum phenomena it was both logical and necessary that this branch of mathematics be extended to include these phenomena. Thus was born the Bose-Einstein and Fermi-Dirac systems of mathematical argument.

The propositions of statistical mechanics are developed on the mathematically exact laws of probability. The theorems of Liouville and Birkhoff on the geometry and kinematics of phase space are at once developed. This is followed by a chapter on the Ergodic Problem (used in the sense of replacing time averages by phase averages) with a formulation on metric indecomposability of reduced manifolds. The following chapters (IV, V) are on the theory of Probability (with discussion of a monatomic ideal gas, equipartition of energy, and Gibbs' canonical distribution). Chapter VI is given entirely to an Ideal Monatomic Gas and Chapter VII to The Foundation of Thermodynamics. The discussion on Entropy is good but exceedingly brief. The translator has done a commendable job.

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TV PICTURE PROJECTION AND ENLARGEMENT, by Allan Lytel, *Lecturer, Temple University Technical Institute.* Cloth. Pages xi+174. Table of Contents. Bibliography. Index. John F. Rider, Publisher, Inc. 1949. Price $3.30.

With the impact of television upon the American scene this little book is well-timed. Although the book appears designed for repairmen and servicemen, it is good reading for the "layman" who might like to know the mystery of this gadget. I have always been appalled by the utter ignorance of owners of radio sets, and automobiles, for that matter, in the fundamental principles of the equipment they own. This is costly business, too, as the record shows. There is no need for this now that printing has been invented and men can read!!

The introductory chapters review the principles of geometric objects, emphasizing mirrors and lenses, reflection and refraction. This leads logically to a discussion of television projection systems with an excellent treatment of commercial applications. The last chapter is on television and motion pictures.

The physics is essentially sound. The mathematics is a minimum. The line

diagrams are excellent, and the captions very appropriate. The chapters end with Questions for Review. The brief bibliography appears to be well-chosen.

The book reads very well and is a good investment for servicemen and owners alike.

JULIUS SUMNER MILLER

LABORATORY EXPERIMENTS IN ORGANIC CHEMISTRY, by Roger Adams, *Professor of Organic Chemistry, University of Illinois*, and John R. Johnson, *Professor of Organic Chemistry, Cornell University*. Cloth. Pages XIV 525. 13.5 21 cm. 1949. The Macmillan Company, New York, N. Y. Fourth Edition. Price. à3.25.

The fourth edition of this popular laboratory manual retains all the excellent features of its predecessors. In addition, the section on laboratory operations has been revised and, in the opinion of the reviewer, has been improved by a more extensive treatment of the underlying principles. The discussions of purification of compounds, distillation, fractional distillation, melting-points, crystallization, steam distillation, extraction, and drying agents are thorough, yet not too advanced, and should serve admirably to give the beginning student an adequate understanding of the principles upon which the more familiar laboratory operations are based.

A wide variety of experiments, well chosen to illustrate important synthetic reactions and followed by a liberal number of pertinent questions, are offered. New experiments, which include an illustration of the Williamson synthesis, of the use of an aliphatic Grignard reagent, of the conversion of an acid to an amide *via* the acid chloride, of the small scale synthesis of a crystalline nitro compound (*m*-dinitrobenzene), of a method for the formation of aluminum chloride directly in a Friedel-Crafts mixture, and of the principles relating to substitution in amino derivatives of benzene, have been added. New syntheses of particular appeal to the students are those of DDT and phenacetin.

Teachers who have used previous editions of the manual will welcome the change in arrangement which permits the figures for apparatus assemblies and the discussions of manipulation and principles to remain intact in the event that the pages of laboratory directions are detached. Altogether, the manual appears to be eminently usable and easily adaptable to use with almost any of the current texts in beginning organic. Teachers of high school chemistry will probably find certain of the experiments of interest for possible use by some of their students.

CALVIN A. VANDERWERF
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PRINCIPLES AND PRACTICE IN ORGANIC CHEMISTRY, by Howard J. Lucas, *Professor of Organic Chemistry, The California Institute of Technology*, and David Pressman, *Associate Member, The Sloan-Kettering Institute for Cancer Research*. Cloth. Pages XI+557. 14.5×23 cm. 1949. John Wiley and Sons, Inc., New York, N. Y. Price $6.00.

This is no ordinary laboratory manual of organic chemistry. It does not consist of a series of recipes for the preparation and testing of the properties of organic compounds. Rather, beginning with the first chapter entitled "Chemical Reactions," which deals with reaction rates, equilibrium, heat of reaction, free energy, and factors that determine yields, an attempt is made to give the student such a thorough understanding of the underlying principles of reaction control and of product purification that he will eventually be able to prepare organic compounds with only very meager directions.

The treatment of theoretical principles is unusually extensive, as are the discussions of general preparative methods and the descriptions of various techniques and types of apparatus. The number of experiments included is sufficiently large to permit different students to work on different experiments simultane-

ously. An abbreviated scheme of organic qualitative analysis is included in the last chapter.

The student, especially one who has had no training in physical chemistry, cannot be expected to master all of the material at once in the exact order in which it is presented. There is much, especially in the early chapters, that will become more meaningful to a student as the course progresses. No one student will be able to perform all of the experiments in a one year course. There are a number of experiments which are not well designed for use by entire laboratory sections in beginning organic. But the better student will find this a stimulating book which provides him ample range for the exercise of his talents, in performing a wide variety of interesting experiments and in mastering the "how" and understanding the "why" of organic laboratory operations.

Actually, this thorough and well written "manual" is an excellent reference book which the student will find incressingly useful in advanced organic laboratory courses and as he begins research. Whether or not he uses *Principles and Practice in Organic Chemistry* in his classes, no teacher of organic chemistry should be without a copy.

C. A. VANDERWERF

FUNDAMENTAL ALGEBRA WITH PRACTICAL APPLICATIONS, by Robert L. Erickson, *Professor of Mathematics, Lebanon Valley College, Annville, Pennsylvania.* Cloth. Pages XI+317, 15×23 cm. Tables of length, area, volume (U. S. & metric), time, angles, four place logarithms of numbers, and four place natural trigonometric functions, 1949. McGraw-Hill Book Co., New York, Toronto, London. Price $2.80.

This book treats the subjects arithmetic and algebra through the material of a strong course in intermediate algebra. It is a basic text appealing to the student's reasoning ability rather than the mechanical solution of exercises. The approach is mature, logical, simple, and practical. A clear presentation is followed by practical illustrative examples and a set of graded problems.

The first chapter on arithmetic is an important part of the text. Perhaps, many students will have that pleasant experience of "seeing" the meaning and relationship of operations and manipulations for the first time. Also, the material is related to the topics in subsequent chapters. Chapter 2 is on positive and negative numbers. It follows and continues this practical line of thought. Chapter 3 develops and applies rational exponents. This gives a foundation for logarithms and their use in solving problems in chapter 4. To note application of the compound interest formula, the use of scientific notation, the explanation of the slide rule, and the discussion of E helps one to understand the purpose of the book.

The literal number is introduced and developed in chapter 5. Chapters 6 and 7 deal with equations, functions, and proportions. Here the functional concept is emphasized. The reviewer agrees with the author that "Diagrams and examples, discussion, problems, and consistent use of functional terms throughout, support and reinforce the concept of functionalism until the functional terminology becomes a part of mental processes of every student who completes the course." Thus the book appeals to one interested in more mathematics, to one interested in vocational, technical, precommerce, or other "pre" courses, and to one interested in intelligent citizenship.

The remaining two chapters give the trigonometry of the right triangle and work on the progressions. The appendix contains 10 pages on statistics. It, also, contains much other material that can be introduced as desired, such as dimensional analysis, determinants, synthetic division, remainder theorem, factorial number, and trigonometric functions by the slide rule.

FOREST MONTGOMERY
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La Grange, Illinois

FIRST YEAR MATHEMATICS FOR COLLEGES, by Paul R. Ryder, *Professor of Mathematics, Washington University.* Cloth. Pages XV+714. 14×21 cm. 1949. The Macmillan Company. Price $5.00.

Many texts on first year college mathematics have been published during the past twenty years. They vary from books containing trigonometry, college algebra, and analytic geometry bound in a single volume to those containing a new arrangement of materials as well as new content. Several texts attempt to give an appreciation and understanding of mathematics without developing the skills usually demanded by engineering and technical schools. This book is conservative as it presents the traditional material of freshman mathematics with some rearrangement to avoid repetition and to give a more logical sequence.

The first 198 pages are devoted to algebra. However, a chapter on rectangular coordinates including areas of triangles, length of a line segment, and point of division precedes the chapter on graphs of functions. Trigonometry including complex numbers follows the work on logarithms and precedes theory of equations. Then comes plane analytic geometry, permutations, combinations, probability, determinants, series, and solid analytic geometry. The individual chapters are usually independent so almost any desired sequence could be followed by instructors using this text.

All of the material found in the traditional course is in this book. Frequently the sequence of topics simplifies the course. The sequence of functions of multiple angles, complex numbers, and theory of equations is an example. The chapter on logarithms is followed by a chapter on logarithmic and exponential functions. Translation of axis is introduced in the chapter on circles and used in studying the conics. Rotation of axis is introduced later in studying the general second degree equation. The usual material on graphing including asymptotes and symmetry comes late in the book and avoids some repetition in the discussion of higher plane curves.

The mechanical features of the book are good; clear type, well arranged pages, mathematical tables, answers to the odd numbered exercises, index, and table of contents. The book serves the needs of those for whom it was written and should be useful as a reference book for elementary mathematics.

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MATHEMATICS YOU NEED, by Eugenie C. Hausle, Benjamin Braverman, Harry Eisner, and Max Peters. Cloth. Pages VIII+376. 1949. D. Van Nostrand Company, New York, N. Y. Price $1.96.

This easy general mathematics text is written primarily for use by classes whose members are not likely to go on with work in the traditional courses in algebra, geometry, and trigonometry. The authors have attempted to include such experience and training in mathematics as will be needed by boys and girls in their everyday lives. They have omitted those materials which are rather difficult, especially where their usefulness is of doubtful value. In selecting topics to be included in the text, the authors have followed very closely the Check List of the recent Guidance Report of the Commission on Post-War Plans of the National Council of Teachers of Mathematics. Dr. Eugenie C. Hausle, one of the authors, is a member of this commission.

The text is neither a review book for arithmetic, nor is it a book of consumer mathematics. It does, however, contain elements of both. While the book does not contain formal lists of exercises for the review of arithmetic, it does present a number of mathematical concepts and processes in which the student is unconsciously being reviewed in fundamental operations. For example, percentage is reviewed in connection with the work on ratio and in the making of circle graphs, while common fractions and decimal fractions are reviewed in the work on algebraic equations and formulas. Throughout the text some 1300 practice exercises

follow the clearly worded explanations and the 100 illustrative examples. There are approximately 400 well chosen figures besides a number of appropriate photographs. Each chapter is concluded with a list of review exercises which summarize its contents. Added interest is aroused by the presentation of some 18 mathematical puzzle problems located at various places throughout the text.

For below average classes the course can be concluded with the completion of Chapter 13 which deals with the application of mathematics to such topics as simple and compound interest, saving money, borrowing money, installment buying, life insurance, social security, and automobile insurance. For the average or above average group, however, Chapters 14 and 15 dealing with the tangent and sine ratios of trigonometry and the hypotenuse rule of the right triangle may be studied prior to Chapter 13 to avoid breaking the sequence of topics.

In preparing this text the authors have kept the average student in mind and have tried to gear the contents to his vocabulary and experience. While the book is intended primarily for those who are not planning to go on with advanced work in mathematics, it also "builds a firm foundation for later work for those who may develop sufficient strength to continue in mathematics."

JAMES B. MAUS
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ORGANIC CHEMISTRY, by G. Bryant Bachman, *Professor of Chemistry, Purdue University.* First Edition. Cloth. Pages x+432. 18×23.5 cm. 1949. McGraw-Hill Book Company, Inc., New York 18, N. Y. Price $4.25.

This text should be particularly suitable for undergraduate college students who are taking a minor course in chemistry. In addition to the material usually covered in textbooks on organic chemistry, this book contains descriptive discussions on the technology of production and purification and the occurrence in nature of various organic chemicals. The inclusion of this discussion should make the text and the subject matter more interesting to the student.

The subject matter covered is broad in scope. One chapter is devoted exclusively to the chemistry of body processes. Another chapter is devoted to chemical constitution of various drugs and their physiological effects.

The text was intended to be used in a full year's course in organic chemistry. If a shorter course is desired, it will be possible to omit some of the chapters without excessive detraction from the course.

The material is clearly presented and is amply illustrated with photographic reproductions and diagrams.

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SUGAR: ITS PRODUCTION, TECHNOLOGY, AND USES, by Andrew Van Hook, *Professor of Chemistry, College of the Holy Cross.* Cloth. Pages ix+155, 14×21.5 cm. 1949. The Ronald Press Company, 15 E. 26th Street, New York 10, N. Y. Price $3.00.

This is a non-technical book for everyone interested in sugar and the sugar industry. The first chapter is the only one containing chemical symbols, a discussion of optical isomerism, and other topics which read like a science textbook. This chapter should have been placed last, changing places with the history of the sugar industry, if the book was meant to attract the general reader. A chapter is given to each of the two great sources, corn and beet. The processes used in preparing the soil, growing and harvesting the crop, manufacturing and refining the sugar, and the grades of sugar and molasses produced are thoroughly and clearly described and explained. Another chapter gives the commercial aspects, showing the principal producing areas, the trade aspects, and the controls on production and marketing. A short chapter is devoted to the various by-products

now in use and the future outlook. Many full page illustrations make the book attractive, and tables of data giving important and interesting information add to its value.

G. W. W.

"NEW STAR," MEXICAN DISCOVERY, EQUAL TO MILLION SUNS

With an energy outpouring of more than a million suns a gigantic "new star" explosion has burst forth in the southern heavens. The nova was picked up among the million stars of the southern galaxy through use of the Schmidt reflector at Tonanzintla National Astrophysical Observatory in Mexico, which is equipped with the largest prism in the world, one of 26 inches.

It takes over 2,000,000 years for light from this nova to reach the earth.

News of the discovery was telegraphed to Harvard Observatory, clearing house for astronomical information.

Sr. Guillermo Haro found that the new object was magnitude 14 when photographed March 15 and 20.

The report from Director Luis E. Erro, of the Mexican observatory showed that the nova is in galaxy number 83 in Messier's catalog and that it is nearly 30 degrees south of the celestial equator in the constellation Hydra on the border of Centaurus.

The nova just discovered is of intermediate intensity. Ordinary novae are about a twentieth as bright, while the supernovae, only about 40 of which are known, average a hundred times brighter.

WISCONSIN GEOLOGISTS AND CANADIAN OIL

JANE DAVIDSON

Mountains of the Canadian Northwest are jagged pieces in a giant puzzle to University of Wisconsin geologists who may aid further Canadian oil discoveries with their basic geological research.

Three years ago, flush oil production from Devonian coral reefs at Leduc, near Edmonton, Alberta, startled oil men. Edmonton, which became a boom town over night, began its morning radiobroadcast, "This is Edmonton, the oil capital of Canada."

Now the bonanza of 300,000,000 barrels of proven reserves at Leduc, the newer and larger field at Redwater, and recent discoveries near Grande Prairie substantiate the early boomtown fever.

But oil men are still looking toward the future and may now use research by Wisconsin geologists to help determine the extent of the new fields which lie beneath the Alberta plains.

Odd as it sounds, the oil men are casting their eyes towards the mountains whose fundamental framework the University rock experts are trying to determine. Which leads to the question, why study the mountains when the oil lies beneath the plains?

Well, according to geologists, rock formations exposed in the high mountains dip eastward beneath the rolling prairies where they are penetrated by the oil drill in the new Canadian fields.

"Work in the exposed rocks of the mountainous areas shows the geologist if the potential oil-bearing rocks lie there," says Prof. L. R. Laudon, director of Wisconsin's Rocky Mountain survey. "This information can then be used by oil men to tell approximately how far to drill in the adjacent prairie to encounter the same potential oil-bearing zones."

Long before the coral deposits yielded oil, Professor Laudon and his students were at work in the wilds of the Canadian Northwest. Their 10 years of geological research, extending from the Mackenzie mountains near the Arctic circle to the United States border, now may furnish clues for further drilling.

"Research funds for this long-term project have come from several sources

and recently from the Wisconsin Alumni Research foundation," Professor Laudon notes.

Just what is the puzzle geologists are trying to put together and how do oil-bearing coral rocks fit into the picture? The answer lies in the geological past.

"It is mainly a problem of deciphering a series of rock formations which extend back through two billion years of time," Professor Laudon explains.

"The ancient core of the mountains which now rise far above the prairie land consists of very old, contorted rocks like those of northern Wisconsin," he says.

"For more than 400,000,000 years western Canada was repeatedly covered by ocean, during which time thousands of feet of sedimentary rocks (sandstone, limestone, and shale) such as are seen in the Madison vicinity, were deposited in the gradually sinking ocean basin.

"The first mountains in the area were raised from the ocean floor over 100,000,000 years ago. Great masses of molten rock forced their way upward along the Pacific coast, thus breaking the sedimentary rock and forcing it eastward in huge blocks to form the Rockies.

"Since that time erosion has been a sculptor, gradually carving the mountains into present day forms," he concludes.

Now the barren mountains stand in layers, like a many decked sandwich. The layers or strata are keys to the period of geological time in which they were formed and possibly keys to future oil production, for fossil coral have been found in limestone strata.

Ancestors of the corals which today build the great barrier reefs around Australia and islands of the South Pacific, were at work building similar reefs millions of years ago in the ancient oceans. The reef builders have died, but their bodies in gradual decomposition may remain as oil in one of the great pools found under the prairie today.

The corals also left their porous reefs behind to hold the oil like a sponge holds water. But coral reefs don't often run in a continuous layer as do other limestone strata.

Geologists believe that if a rock outcrop filled with fossil corals is found in the mountains, a similar condition may be found somewhere in the adjoining prairie.

"We are interested in finding out how much of this mountainous country has coral outcrops which suggest corresponding prairie reefs that may produce oil," Professor Laudon points out.

Great strides over numerous mountain ranges cannot be made in one summer. Seven league boots are not part of the geologist's equipment. Time is one of the tools needed to probe the geological past.

So, Wisconsin's geologists are going back again this summer. This time they will concentrate their work in Montana. In future years they plan to work southward into Utah, Nevada, and Arizona, adding more pieces to the giant puzzle of mountain and prairie.

BRONK NEW PRESIDENT OF NATIONAL ACADEMY OF SCIENCES

Dr. Detlev W. Bronk, president of the Johns Hopkins University, will become president of the National Academy of Sciences, the "senate" of American science, on July 1, as the result of the quadrennial election held here.

He will succeed Dr. A. N. Richards of the University of Pennsylvania, now NAS president.

Dr. Bronk is chairman of the National Research Council, the operating body of the Academy. He is a biophysicist.

Dr. Roger Adams, head of the Chemistry Department at the University of Illinois, was elected foreign secretary. Dr. Walter S. Hunter, Brown University psychologist, and Dr. Oliver E. Buckley, president of the Bell Telephone Laboratories, were elected to the Academy's council.

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